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The Research Council Theater Liaison Program

By WILLIAM F. KELLEY

The Motion Picture Research Council conducted, for three years, a program intended to improve picture and sound reproduction in the theater. The results speak for themselves, and the conclusions can be drawn by the reader.

THE THEATER LIAISON activity of the Motion Picture Research Council, Inc., gathered facts that make this report important to everyone concerned with the overall health of the industry.

This summary treats only of the important first-run theaters in large cities.

In 74% of these theaters optimum focus could not be obtained. In 63% of the theaters the failures were due to mechanical misalignment which was corrected on the spot (such misalignment also may contribute to shortened print life). The remainder were due to worn parts or to substandard optical components. Such conditions were reported to executive management. Management's interest in the reports indicated that these recommendations would not be ignored.

Precision gages and lens performance test film were used to determine and to correct these conditions. These tools were developed by the Research Council engineering staff. They will be made available to theater technicians at the lowest possible cost and will be described in articles in trade magazines. It may be expected that conditions causing less than optimum picture sharpness will be corrected in other theaters throughout the world as these tools are put to use.

Screen Brightness

In 69% of the theaters visited, recommendations were made to correct undesirable screen brightness levels and undesirable brightness distribution to the various seating areas. The harm this condition is doing to the proper presentation of Hollywood product cannot be exaggerated. These conditions would not exist if the proper type of screen were correctly installed, and adequate arc-lamp equipment used.

In all these cases, facts about screen characteristics and proper installation were discussed with technical personnel and with owners and executive management. Articles and charts emphasizing the importance of these considerations were widely circulated by the Research Council theater staff.

The subject of screen brightness is examined more comprehensively and some case histories from the files are described in another section of this report.

Lenses of the Wrong Size

In 43% of these theaters recommendations were made to procure lenses of a different focal length than that being used in order to show either anamorphic or regular product to better advantage. In most cases where the wrong size of lenses was used, intended picture information was being eliminated (sometimes drastically) by undersize apertures which compensated the error in lens focal length for a given picture size.

Owners and executive management were very interested in learning of these conditions. As a means of focusing attention on this problem, a scaled chart was incorporated in an all-purpose projector test film developed by the Council. This chart indicates at a glance precisely how much of the intended picture information is being lost in projection.

The widespread use of this film has been encouraged through articles in the trade magazines and in letters to theater chain executives.

Picture Masking

In 40% of these theaters recommendations were made to correct undesirable picture masking practices. No one can deny that an unmasked picture showing aperture edged (and possible lint that may collect) on the bare screen detracts from the appearance of the projected picture.

In reports to top management in these theaters the Council theater staff has suggested that the aesthetic value of neat trim masking of the picture on the screen be reconsidered.

Print Life

One of the important causes of shortened print life is the use of sprockets of relatively small diameter. The Council theater staff urged replacement of undersize sprockets wherever they were found.

Another important cause of shortened print life was found to be improper alignment of the projector film path. Gages to facilitate this alignment have been made available to theater technicians, described in articles in trade magazines, and technical personnel in large theater circuits were advised of their availability.

Sound

Many of the more enterprising exhibitors complained that too few stereophonic sound prints were being made available. Some expressed the opinion that the increasing public interest in stereo sound used in home sound systems, radio and some TV programs should be considered seriously by both producers and exhibitors.

Conditions of Prints Received From Exchanges

Many complaints have been made to the Council theater staff by theater management and projectionists about the condition of prints delivered to the theaters, especially the subsequent-run theaters and drive-ins. The most common complaints were:

(1) scratched prints;
(2) unrepaired damaged splices;
(3) damaged leaders, leaders of improper length (footage missing), leaders not spliced to reel, and on some occasions, missing leaders;
(4) damaged, bent reels; and
(5) damaged containers (especially the cardboard type recently put in use).

Presented on October 5, 1959, at the Society's Convention in New York by William F. Kelley, of the Motion Picture Research Council, 9310 Elben Ave., Sun Valley, Calif.
(This report in final form was received on October 18, 1960.)

These widespread complaints point to improper handling and inadequate inspection in the exchanges, and necessitate extra booth time in the theater for inspection and repair.

Drive-In Theater Screen Brightness

Screen brightness is the principal concern of this type of exhibition. In 57% of all drive-in theaters visited in 1959, screen brightness levels were under 3 ft-L when regular product was being shown and in only 5% were brightness levels found to be over 5 ft-L. Brightness levels such as these greatly detract from good presentation.

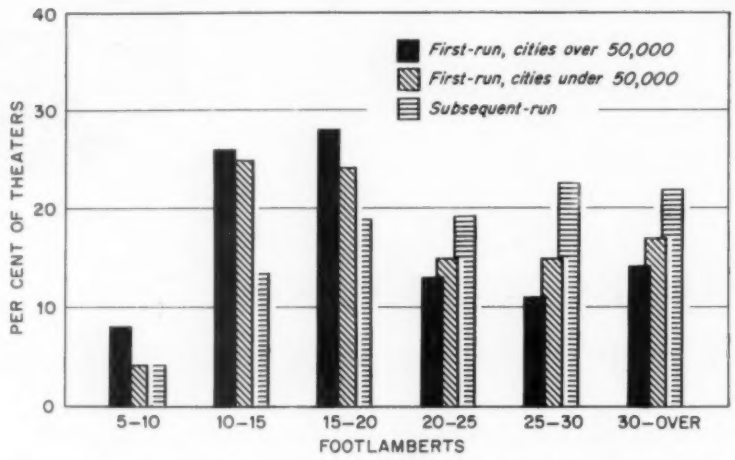
Increasing the efficiency of screens used in drive-ins is of course the most desirable solution to this problem. There were no screen brightness problems where the excellent aluminum screen developed by the Council had been installed. In most cases the installation of this screen required comparatively costly modification of the screen tower. The result has been that only some 50 of these screens were in use. Recently, the manufacturer inaugurated a direct sales policy which lowers the cost of the screen 30%.

The development of another type of screen for drive-ins which uses the same optical principles was studied by the Council engineering staff. The goal of this study was the perfection of a screen that, in the great majority of installations, would not require expensive tower modification. The major goal, of course, was an installed price that will assure wide use of these screens in drive-in theaters.

General Observations

The Council theater staff had an unusual opportunity to meet and to exchange ideas with many people in all activities and all categories of authority in motion-picture exhibition. After visiting some 700 theaters in more than 100 cities in 12 states, the staff have become firmly convinced that theaters which are well run are doing better business. Few technical deficiencies are found in such theaters. The presentation is pleasing and smooth. The picture is sharp, the screen brightness is right, the picture is properly masked. Attendants are courteous, there is adequate air turnover, the sound is clear and the overall condition of the theaters is good. In such theaters the only complaints heard about product were that there should be more of it. These theaters were observed to be well attended when showing average good product, and turned people away on weekends when showing pictures that happened to "click".

It seems logical to hope that improving presentation practices in our theaters will result in a healthier industry. If this is true, the more room for improvement found, the more benefit may derive from stimulating action in the proper direction.



Some among management have seemed too prone to criticize projectionists. Blanket criticism does not, of course, solve anything, and in this case cannot be justified in the overall picture. It has been the experience of the Council theater staff that projectionists, as craftsmen, are conscientious and competent, and show an above-the-ordinary interest in their jobs that is praiseworthy. In one city, for example, fourteen projectionists spent half a day on their own time at theaters being visited by a Council field man.

Generally, where undesirable conditions such as have been described were found, the responsibility does not lie exclusively in one place. In order to evaluate where it does lie, one must know something of the concerns, attitudes and principal interests, as well as of the technical understanding, of everyone from theater owner to executive manager to equipment manufacturer to equipment supply dealer to theater district manager to house manager to projectionists. Accessibility to correct information and uncomplicated liaison through all levels of authority are most important.

Solutions to Common Problems

From expressed reaction, and from the many letters received by the Research Council from exhibitors in areas visited by the Council theater field staff, this program was fruitful in promoting good will within the industry. It was effective in carrying forward its intended objectives. This was done, not only directly, in the theaters which have been visited, but on a broader scope, in the study of problems common to theater presentation everywhere. Solutions to such problems as heat on film, focal drift, excessive print wear, the design of practical inexpensive gages for accurate film path alignment, and a long-needed new all-purpose projector alignment film have resulted. These contributions will continue to improve the quality of exhibition far beyond the areas that have been visited by the Council theater staff in carrying forward this work.

Explanation of Tables

The theater operational data which seemed to be of greatest general interest have been compiled in Tables I–XIII and a graph (Fig. 1.) has been made to accompany Table I.

Over 700 theaters were contacted, of which 68% were indoor theaters and 32% were drive-ins. The operational information from indoor and drive-in theaters was compiled separately for obvious reasons.

An initial inspection of the information made it evident that average conditions, particularly in some categories such as screen brightness, differed in first-run and subsequent-run houses. For this reason, the indoor theaters were divided into three categories: first-run in cities of over 50,000 population, first-run in cities of less than 50,000 population, and second-run and subsequent-run theaters. Of the indoor theaters approximately 38% fell into the first category, 22% into the second and 40% into the third.

The information on actual dimensions of apertures was included to show the amount of cropping on CinemaScope width and wide-screen height, particularly for indoor theaters. The screen aspect ratio for drive-in theaters was included because in CinemaScope projection the sides of the screen are often overshot and the screen becomes the determining factor of the aspect ratio of pictures as actually seen.

The data represent conditions "as found" at the time the theater was surveyed. Where undesirable practices were encountered, such as excessive center screen brightness, poor screen brightness distribution and excessive picture area cropping, recommendations were made to management for their correction. These corrections are not reflected in the Tables.

Fig. 1. Graphic presentation of data of Table I — Center Screen Brightness of Indoor Theaters Wide Screens (presented as an example of the graphic presentations in the Research Council Report).

Table I. Center Screen Brightness — Indoor Theater — Wide Screen.

Foot-lamberts	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run
5 – 10	8%	4%	4%
10 – 15	26	25	13.5
15 – 20	28	24	19
20 – 25	13	15	19
25 – 30	11	15	22.5
over 30	14	17	22

Center screen brightness in the majority of large city first-run theaters is in the 10–20 ft-L bracket, but in general is higher in smaller city first-run and in subsequent-run theaters. Brightness levels of over 20 ft-L are undesirable because they cause objectionable flicker and are usually accompanied by excessive brightness fall-off at the sides of the screen. Arc-lamp equipment not designed for large-screen coverage and highly directional screens are responsible for these conditions.

These center screen brightness readings were made from the center of the auditorium, halfway between the screen and the last row of seats.

Table II. Center Screen Brightness — Indoor Theaters — CinemaScope.

Foot-lamberts	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run
5 – 10	13%	3%	2%
10 – 15	17	14	12
15 – 20	23	20	20
20 – 25	20	18	18
25 – 30	13	24	29
over 30	14	23	19

CinemaScope center screen brightness in general is higher than wide-screen center brightness in a given theater. Where this condition exists, it is due to the increase in light resulting from the use of longer focal length CinemaScope prime lens overcoming the loss of the added glass elements of the anamorphic attachment and the reduction in CinemaScope brightness due to the horizontal spreading of the light.

These center screen brightness readings were made from the center of the auditorium, half-way between the screen and the last row of seats.

Table III. Center Screen Brightness — Drive-In Theaters.

Foot-lamberts	Painted surface — Wide screen	Painted surface — CinemaScope	R. C. Aluminum Screen — Wide screen	R. C. Aluminum Screen — CinemaScope
1 – 2	10%	7%	—	—
2 – 3	43.5	37.5	—	—
3 – 4	31	38.5	—	—
4 – 5	10.5	14	27%	—
5 – 6	3.5	1	18	30%
6 – 7	0.5	2	27	20
7 – 8	1	—	—	10
8 – 9	—	—	—	—
9 – 10	—	—	10	10
over 10	—	—	18	30

Over 53% of the drive-in theaters surveyed had less than 3 ft-L center screen brightness when showing regular product. Painted screen readings above 3 ft-L may be attributed to relatively smaller screens or screens of medium size using excellent arc-lamp equipment. All installations of the Research Council Aluminum Screen had over 4 ft-L with the average well above this figure. Readings under 6 ft-L on Research Council Aluminum Screens may be attributed to inadequate arc-lamp equipment.

Table IV. Side to Center Brightness Ratio — Indoor Theaters — Wide Screen.

Light distribution	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run
20 – 30	3%	6%	3%
30 – 40	10	6	6
40 – 50	17	8	13
50 – 60	22	28	30
60 – 70	29	22	22
70 – 80	14	18	16
over 80	5	12	10

In over half of the theaters surveyed the brightness at the sides of the screen was less than 60% of the center screen brightness. As fall-off increases from this ratio it proportionately detracts from good presentation. Principal causes are the use of directional screens which are improperly curved or not curved at all. Fall-off increases when the use of uncurved screens with higher directional characteristics may combine with inadequate or improperly adjusted arc-lamp equipment.

Brightness readings represented in these Tables were made from the center of the auditorium.

Table V. Side to Center Brightness Ratio — Indoor Theaters — CinemaScope.

Light distribution	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run
20 – 30	3.5%	8%	5%
30 – 40	8	8	10
40 – 50	14	9	17
50 – 60	33	21	24
60 – 70	22.5	33	23.5
70 – 80	11	11	11.5
over 80	5	10	9

Table VI. Directional Screen Brightness Ratio — Min. to Max. Brightness Viewed From Side of Auditorium.

Light distribution	Curved screen	Flat screen
0 – 10	—	30%
10 – 20	1.5%	—
20 – 30	4	26
30 – 40	8	22
40 – 50	14	8.5
50 – 60	24	9
60 – 70	22	4
70 – 80	17	0.5
over 80	9.5	—

These data indicate the ratio of the darkest to the brightest portions of the screen as viewed from the side of the auditorium, halfway between the screen and the rear row of seats. The measurements emphasize that it is necessary to curve directional screens in order to have acceptably uniform screen brightness from side viewing positions. A ratio of less than 20% noticeably detracts from presentation quality; 20–40% is undesirable; ratios of 40–60% may be considered acceptable, and ratios over 60%, where directional screens are used, are very good. Only 3% of the flat-screen installations are in this latter category as compared to 60% of the screens which are curved. The higher the directional characteristics of the screen, the more essential it becomes that Research Council recommendations for curvature be followed. Screen curvature introduces some distortion, however, and in theaters with wide auditoriums, high balconies and steep angles of projection, the use of directional screens is not recommended.

Table VII. Aperture Aspect Ratio — Wide Screen.

Aperture aspect ratio	First run, in cities		Subsequent run
	Over 50M	Under 50M	
1.3 – 1.4	—	—	4%
1.4 – 1.5	1%	—	2
1.5 – 1.6	7	—	6
1.6 – 1.7	22	22%	21
1.7 – 1.8	26	41	27
1.8 – 1.9	28	27	30
1.9 – 2.0	12	10	8
2.0 – 2.1	4	—	—
over 2.1	—	—	2

Over 80% of the theaters surveyed project wide screen at an aperture aspect ratio between 1.6 and 1.9 to 1. Some theaters have spare apertures which may be used when it is desirable to show more of the available height, for example, foreign prints, news-reels and re-issues which were composed in photography for a lesser aspect ratio. These special apertures have not been considered as wide-screen presentation and are not included in the data.

Table VIII. Aperture Sizes – Wide Screen — Height Only.

Aperture height, mils	First run, in cities		Subsequent run	Drive-in theater apertures
	Over 50M	Under 50M		
390 – 400	—	—	—	1.5%
400 – 410	1%	—	1.5%	3
410 – 420	2	—	2.5	5
420 – 430	3	1%	3	1.5
430 – 440	9	1	9	6.5
440 – 450	20	12.5	10	10
450 – 460	10	10	11.5	6
460 – 470	12	18	8	10
470 – 480	12	21.5	14.5	13
480 – 490	6	12.5	8	8
490 – 500	8	14	14.5	9.5
500 – 510	7	7	3.5	6.5
510 – 520	5	2.5	1.5	3.5
520 – 530	1	—	3	2.5
530 – 540	3	—	2.5	0.5
over 540	1	—	7	13

Over 50% of the indoor and 39% of the outdoor theaters surveyed used wide-screen apertures from 440 to 480 mils in height. In some degree the various studios use different height ratios in camera composition. As a consequence, in theaters using aperture heights outside the limits described above, composition is altered in projection proportionately to heights indicated in this Table as compared to camera composition.

Table IX. Aperture Aspect Ratio — CinemaScope.

Aperture aspect ratio	First run, in cities		Subsequent run
	Over 50M	Under 50M	
1.9 – 2.0	1%	—	4%
2.0 – 2.1	3	8%	5.5
2.1 – 2.2	8	10	17.5
2.2 – 2.3	17	18	17.5
2.3 – 2.4	44	36	37
2.4 – 2.5	22	23	12.5
over 2.5	5	5	6

Of the theaters surveyed, 37% used CinemaScope apertures having aspect ratios below 2.3 to 1. Over 20% used apertures of wider aspect ratios than that recommended for showing anamorphic product. The latter group includes some apertures of undersize height as well as others of oversize width. It may be assumed that corrections in this category have now been made in theaters thus far surveyed. Screen size and lens focal length availability (in $\frac{1}{4}$-in. steps) plus the need for adequate picture height in some cases make necessary the use of somewhat undersize apertures. When CinemaScope aperture aspect ratio is reduced to as much as 2 to 1, approximately 15% of picture information at the sides is lost. In such cases, recommendations were made for use of longer focal length prime lenses in situations where resulting slightly reduced picture height was acceptable.

Table X. Aperture Sizes — CinemaScope — Width Only.

Aperture width, mils	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run	Drive-in theater apertures
690 – 700	—	—	—	2.5%
700 – 710	1%	1%	3.5%	5.5
710 – 720	2	—	1.5	5.5
720 – 730	1	2.5	1.5	1.5
730 – 740	1	6	2.5	2.0
740 – 750	3	2.5	2.5	3.0
750 – 760	3	—	5.5	1.0
760 – 770	3	1	1.0	1.0
770 – 780	6	3	5	5.0
780 – 790	7	6	7	5.0
790 – 800	5	4.5	10	2.5
800 – 810	6	8	8.5	5.5
810 – 820	10	13.5	8.5	2
820 – 830	17	8	11	13
830 – 840	17	15	17	18
840 – 850	13	19	6	8
over 850	5	10	9	19

These data showing aperture sizes in mils were prepared to give a specific breakdown on the actual picture area lost through the use of undersize CinemaScope apertures.

In 62% of the theaters surveyed, undersize apertures were, to some extent, cropping the width of the picture.

Some latitude in aperture width used is unavoidable because of focal length availability and screen size. Where practicable, recommendations were made to use longer focal length lenses with larger aperture opening. In the case of apertures used for anamorphic product in drive-in theaters, it must be considered that some theaters overshoot the screen in projected picture width. This results in cropping of more picture width than may be indicated by aperture measurements in these theaters. This fact was taken into consideration in recommendations for lens focal length changes where such recommendations were made.

Table XI. Aperture Sizes — CinemaScope — Height Only.

Aperture height, mils	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run	Drive-in theater apertures
under 675	15%	14%	17%	20%
675 – 680	8	2	6.5	6
680 – 685	5	1	3	4.5
685 – 690	8	2	4	2
690 – 695	4	10	7	8
695 – 700	7	7	6	4.5
700 – 705	8	10	6.5	5
705 – 710	10	7	7.5	3.5
710 – 715	25	32	30.5	26
over 715	10	15	12	20.5

About 15% of indoor theaters and 20% of drive-in theaters thus far surveyed use CinemaScope apertures of less than 675 mils in height. This amount of cropping may affect pictorial composition and cause important picture information to be lost. In these cases, use of a longer focal length prime lens and larger aperture opening was recommended. At the other extreme, 12% of indoor theaters used CinemaScope apertures over 715 mils in height, allowing screen masking to absorb unwanted projector picture height. In such cases, recommendations were made to install new aperture plates of proper size. About 15% of the theaters having large size screen installations prefer to use CinemaScope apertures sufficiently undersize in height to eliminate the negative splice flashes across the top or bottom of the screen. To accomplish this requires a reduction in aperture height to about 690 mils.

Table XII. Screen Sizes — Indoor Theaters — Width Only.

Screen width, ft	First run, in cities — Over 50M	First run, in cities — Under 50M	Subsequent run
15 – 20	—	—	3%
20 – 25	—	—	5
25 – 30	4%	13%	18.5
30 – 35	16	29	27
35 – 40	30	25	28
40 – 45	27	27	11
45 – 50	13	5	5.5
50 – 55	5	1	2
55 – 60	3	—	—
60 – 65	1	—	—
over 65	1	—	—

Of the theaters surveyed 10% used screens over 50 ft in width. Of this number 80% were in large city first-run theaters. Of all indoor theaters surveyed 70% used screens under 40 ft in width.

Table XIII. Drive-In Theaters.

Picture aspect ratio	Wide screen	Cinema-Scope	Screen aspect ratio		Screen width, ft	
1.3 – 1.4	5.5%	—	1.3 – 1.4	1%	50 – 55	2%
1.4 – 1.5	5.5	—	1.4 – 1.5	0	55 – 60	1.5
1.5 – 1.6	5.5	—	1.5 – 1.6	1.5	60 – 65	2.5
1.6 – 1.7	20	0.5	1.6 – 1.7	2.0	65 – 70	2.0
1.7 – 1.8	27	0.5	1.7 – 1.8	4	70 – 75	2.5
1.8 – 1.9	18	0.5	1.8 – 1.9	5	75 – 80	8.5
1.9 – 2.0	11.5	4.5	1.9 – 2.0	12	80 – 85	17.5
2.0 – 2.1	6	17	2.0 – 2.1	25	85 – 90	4
2.1 – 2.2	1	14	2.1 – 2.2	10	90 – 95	12
2.2 – 2.3	—	9	2.2 – 2.3	12.5	95 – 100	8
2.3 – 2.4	—	27	2.3 – 2.4	10	100 – 105	18
2.4 – 2.5	—	16	2.4 – 2.5	8	105 – 110	5
over 2.5	—	11	2.5 – over	9	110 – 115	6.5
					115 – 120	6
					120 – over	4

In analyzing picture aspect ratio of anamorphic product in drive-in theaters, the screen aspect ratio must be given greater consideration over the aperture aspect ratio.

Of the drive-in theaters thus far surveyed 17% have screen aspect ratios greater than 2.35 to 1. These theaters, in order to fill the total screen width, must overshoot the height of the screen. In 83% of the theaters the screen aspect ratios are less than 2.35 to 1, and tend to fill the screen in height, but overshoot the screen width, or mask the intended picture width at the aperture. Of all drive-in theaters visited 50% had screen aspect ratios of 2.1 to 1 or less.

Of these drive-in theaters 65% used aperture aspect ratios between 1.6 and 1.9 to 1 for wide-screen presentation.

Of the drive-in theaters surveyed 40% have screens in excess of 100 ft in width.

The Research Council Developments for Better Theater Projection

BY WALTER BEYER

An extensive theater liaison program undertaken by the now disbanded Motion Picture Research Council stimulated several very important advancements in theater projection during the past few years: (1) a plastic drive-in screen with a gain of more than 2.5; (2) an inexpensive light meter capable of reading both incident and reflected light; (3) a liquid heat filter to reduce heat on film and lens focus drift; (4) 35mm and 70mm projector alignment films; and (5) a film-path gage and an optical alignment tool.

MOTION-PICTURE viewers throughout the country are now enjoying the indirect benefits of improved presentation, much of it due to the adoption of new methods for checking technical performance of equipment by means of tools and instruments designed by MPRC engineers in the course of extensive laboratory tests and inspection of well over a thousand indoor and drive-in theaters (see preceding paper by William F. Kelley in this issue of the *Journal*). Projectionists and maintenance engineers have found in the application of these new methods and tools many solutions to some very vexing problems.



Fig. 1. MPRC Brightness Meter for indoor and drive-in screen brightness readings.



Fig. 2. Brightness Meter with photosensitive cell for incident light readings.

Of particular interest is the screen-brightness meter shown in Fig. 1, a device especially designed for brightness range readings of 0–30 ft-L, with a pickup angle of 1.5° and compatible to any "spot" meter. Viewed through an eyepiece, the brightness of a small doughnut-shaped ring, may be regulated to blend completely against the brightness of the screen area to be measured. Filters to reduce and to extend the reading range of this meter are available. For low brightness readings (required by drive-in theater screens) the scale may be reduced to 0–5 ft-L. For higher readings the scale may be extended to 0–300 ft-L. A neutral opal disc is available for screen gain measurements. In addition, a light-sensitive selenium cell may be plugged into the meter for incident light readings (Fig. 2) and the footlambert scale may be read directly in foot-candles. To obtain readings over the entire area of the screen, this cell may be connected by an extension cord and used as a foot-candle meter for recording incident light and to check the efficiency of the lamphouse and of the projector.

Screen brightness in drive-in theaters has long been troublesome, the average brightness on screens with painted surfaces being only 2.75 ft-L. With the MPRC lenticulated aluminum screen, a brightness range of 6–10 ft-L has been obtained. A disadvantage of this type of screen is the installation problem created by the necessity of rebuilding existing towers to introduce the correct tilt for good vertical light distribution. This otherwise excellent type of screen is being installed in new drive-in theaters where the towers meet the specifications.

Shown in Fig. 3 is a later type of screen for drive-in theaters. Of a lightweight plastic construction, embossed during manufacture, the plastic material is thin enough to offer excellent flow characteristics and it can be cemented easily on half-inch plywood. The special features of this material are lightness and the molding of horizontal rows of embossing with a predetermined tilt. A vertical tower can accept the screen material because the panel comes with built-in tilt, the angle of which increases with the height of installation. An aluminum coating, having a gain of approximately 2.5, with no falloff, will readily accommodate high screen brightness of ±50° viewing angle to both sides of the center line.

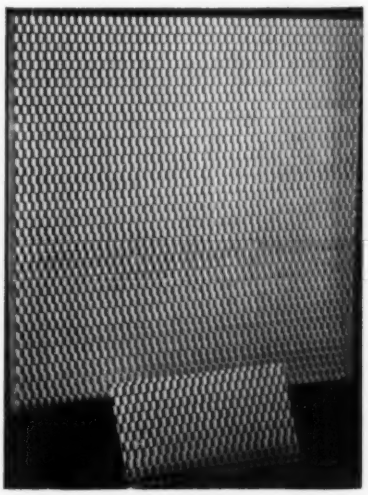


Fig. 3. Samples of plastic drive-in screens.

Projector Alignment Films

Two valuable all-purpose projector alignment films, a camera original 35mm, and a 70mm (to meet requirements for new road show installations), were developed and put into operation.

The 35mm is the first one of its kind and is more accurate than a print. The Mitchell NC camera, used in a precision optical bench setup to shoot a target directly, is equipped with positive register pins and with a printer aperture with center line 0.738 in. from the guided edge. The positive release stock exposed in this camera may, after processing and waxing, be directly projected on the screen. The Mitchell NC produces a rock-steady camera original that can be used for both anamorphic and wide-

Presented on October 5, 1959, at the Society's Convention in New York by Walter Beyer, then with Motion Picture Research Council (now disbanded); now Head of Engineering Research, Universal-International Pictures, Universal City, Calif.

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screen projection. The following checks can be made with it: aperture measurement, height steadiness, side weave, travel ghost, focus, buckling, and squeeze ratio. The target (Fig. 4) is designed with the vertical center line 0.738 in. from the guided edge for both anamorphic and wide-screen apertures. The maximum outside lines represent an aperture of 0.839 by 0.715 in. The dimensions of the aperture of 0.825 by 0.600 in. are within this field. Sufficient vernier scale lines (in a tapered arrangement) are provided on side, top and bottom along the respective center lines. The side vernier scale lines are 0.001 in. The top and bottom are 0.002-in. and spaced 0.010 in. Horizontal and vertical scale lines thus appear on the screen to be of equal thickness, when projected at an anamorphic ratio of 2 to 1.

The target for the 70mm all-purpose projector alignment film may be used for making the same measurements, and the checking procedures are the same. While the recommended 70mm aperture is 1.913 in. wide by 0.868 in. high, smaller apertures have been successfully used, especially with anamorphic prints. The test film chart is provided with vertical and horizontal scales for measurement of such apertures. The chart also provides indices for measurement widths of 2.050 to 1.690 in. Slightly elongated markers along the horizontal center pattern indicate the dimensions of 1.3, 1.4, 1.5 and 1.6 in. All vernier scale lines on sides, top and bottom are 0.002 in. wide, and are spaced 0.010 in. The vertical center line of the target is identical with the film's centerline 1.377 in. from the guided edge. Magnetic stripes without sound have been applied outside both perforations to provide a thickness identical to that of the 70mm release prints. No gate adjustment, therefore, is required between running the test film and running a release print. The target and the lettering on both films are white on medium-dense background.

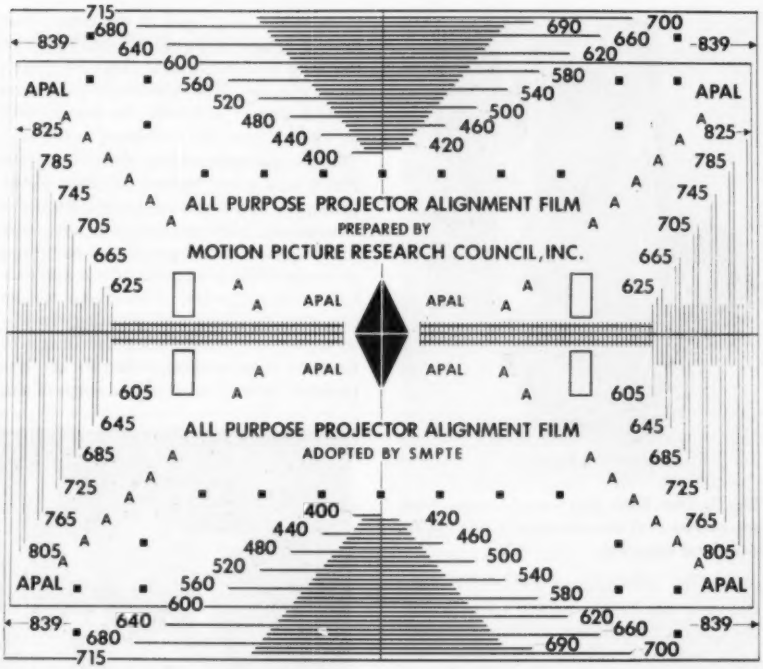


Fig. 4. Test Target Chart of MPRC 35mm projector alignment film (APAL). A Test Target Chart is also available for 70mm projector alignment.

The Liquid Heat Filter

With large-screen presentation, the heating of the film became an acute problem. Extensive tests by MPRC showed poor focus (caused by film buckling) to result from radiation of the arc light. This radiation produced a new phenomenon, given the term "lens focus drift." Color film, even when completely opaque, will transmit all the infrared to the lens. The effect, comparable to a change in focal length, produces an undesirable out-of-focus and blurred image.

To deal with the problem of lens focus drift the MPRC came up with a design for a $\frac{7}{8}$-in. thick liquid heat filter having a free opening of $5\frac{1}{2}$ in. to accommodate the beam of any existing mirror arc lamp. By absorbing the long-wave infrared to which the lens elements are opaque, this filter almost entirely eliminates lens focus drift. The filter, shown in Fig. 5, consists of two Vicor plates with liquid between them, and has an outer hollow rim which has to be cooled either by means of a recirculator or by tap water. To increase its effectiveness, the front plate may be coated with a heat-reflecting dichroic filter. The dichroic filter absorbs short-wave infrared and helps to prevent buckling in black-and-white film.

The reflective coatings of dichroic heat-deflecting glass filters (usually placed directly in the light beam) suffer by reason of dust particles which fall on the surface, absorb the light of the beam and, by overheating at contact points, cause pinholes or tiny cracks, leading to rapid deterioration. The continuously-cooled liquid dichroic filter (Fig. 6) has better lasting power. The liquid filter also protects heat-sensitive gelatin filters used in motion-picture printers, and in still plates in stereopticons. Of shallow construction, it has no effect on distribution of light, mounted between the 35mm or the 70mm projector head and the lamphouse.



Fig. 5. Liquid heat filter.

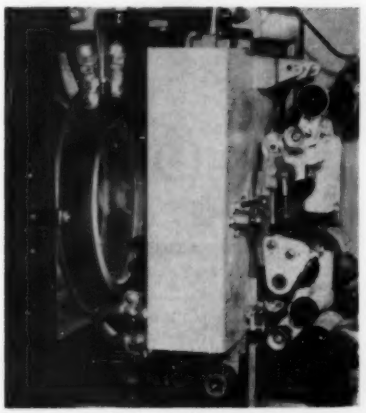


Fig. 6. Liquid heat filter on 70mm projector under operating conditions.

Film Path Alignment Gage

One of the most important MPRC achievements was the assembly of a set of tools used for mechanical and optical alignment of all makes of projectors. The film path gage (Fig. 7), machined in accordance with American Standards for film width and sprocket dimensions, mechanically lines up the fixed guide roller and the guide rails with the nar-

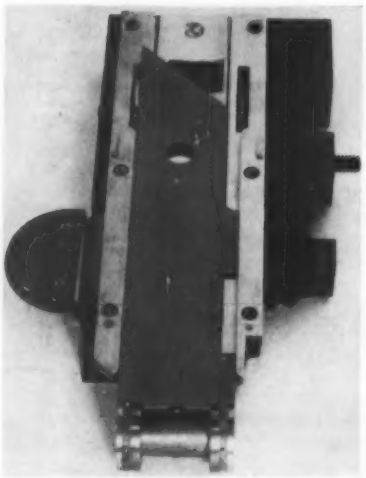


Fig. 7. Film Path Alignment Gauge used for mechanical alignment of guide roller, rails and sprocket.

row-tooth intermittent sprocket. When the gate has been opened, or removed, the gage is fitted smoothly between guide rails with the pointed tip toward the fixed guide roller, its notches engaging the teeth of the sprocket. If the gage does not fit between the guide rails, a slight adjustment is necessary for clearance to avoid film cupping. If the gage does not mesh with the sprocket teeth, the sprocket needs replacing. During alignment, it may become necessary to reposition the guide roller, the guide rails or the sprocket to ensure that film is pulled through the gate perpendicularly, and that the sprocket does not damage film by contacting perforations in the radii corners.

The kit contains an optical alignment tool (Fig. 8), that may be used under operating conditions. This versatile tool has two main parts: a lens extension tube with attached cone and a removable tube with observation mirror. The small end of the cone is, in effect, a pinhole camera which transmits an image on the ground glass at the large end of the cone. This ground glass is equipped with center marking and concentric rings for alignment purpose. The removable tube contains a mirror in which the image may be viewed from any operating position.

With the gate clear, the tool is inserted in the lens mount (in place of the projection lens) about one inch from the film plane. After striking the arc, with the projector running and dowser open, an image of the projection mirror and carbon holders appears. This image may be observed by tilting and pivoting the observation mirror, showing the image of the mirror in the lamphouse as an illuminated disc. The shadow-image of the carbon holder will be seen inverted, extending downward to the center of the ground glass. By adjusting the horizontal and vertical mirror knobs for uniform illumination, it is possible to tilt the mirror and carbon holder to the precise positions required for top performance. Loss in the reflective coating of the mirror causes blotches on the ground glass which will not disappear during adjustment.

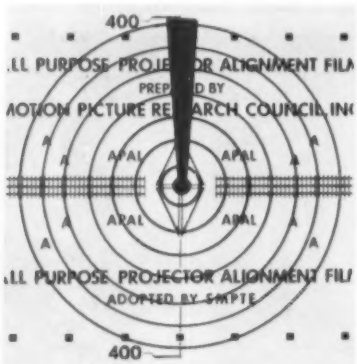


Fig. 9. Picture of Test Film Target and shadow of carbon holder as they appear in relation to center marking and orientation rings inside the optical alignment tool.

When the illumination system has been thoroughly checked, the projector may be threaded with the all-purpose projector alignment film included in the kit. Figure 9 shows the center portion of the target film as it appears on the ground glass, when the projector is running. With no aperture in the gate, the projectionist frames the center diamond on the film to the center of the ground glass to determine if the entire film path is horizontal and in line with the optical axis. When the center marking on the ground glass appears within the short axis of the white diamond on the film, the film path is aligned horizontally, within acceptable tolerances. At this stage, the tool may be removed and, by reinserting the lens, with no aperture in the gate, the entire target may be projected. Since the film (in the projector) is on the true optical axis of the lens, the vernier scales on the side, top and bottom will allow overall orientation of the projector After reinsertion of the projector aperture, with film in the gate, the edge of the aperture should not appear on the screen. Should it appear, the aperture is filed off center from the optical axis. This convenient alignment tool enables the projectionist to achieve optimum light distribution and excellent focus over the entire screen, the lens and film centers perfectly coinciding with the center of the screen.

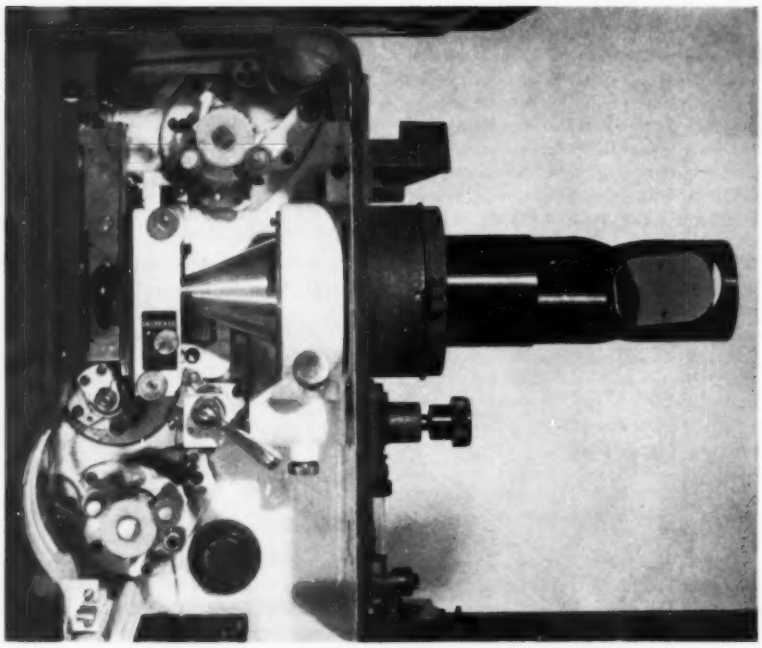


Fig. 8. Optical Alignment Tool ready for use in a 35mm projector lens holder.

Acknowledgments

The achievements outlined above were made through the efforts of many people. The Theater Liaison Program of the Research Council was made possible by the Motion Picture Producers Association and the Board of Directors of the Research Council. Under the guidance of William F. Kelley, MPRC President, Field Engineers Fred Beard and Dan Haworth collected material and ideas for this research. Petro Vlahos, MPRC Staff Engineer, developed the brightness meter, drive-in screen, projector alignment tools and liquid heat filter. The author, who at that time was MPRC Mechanical Engineer, gathered the data used in making up the test charts, and photographed the test films.

A Transistorized Vidicon Camera for Industrial Use

By M. H. DIEHL

A compact, single-unit camera has been designed to be capable of a high-quality television picture. Problems encountered in transistorizing video, sync, sweep and power supply circuits are discussed. There are four integrated optical accessories: remote focus, remote iris, remote turret and douser. Performance characteristics of the camera under conditions of shock and vibration, temperature extremes and high acoustical noise level are given.

Applications of closed-circuit television extend from baby-sitting to bird-watching, the bird in this case being a missile at the test stand or on the launching pad. In between these extremes are many industrial and military uses where observation by humans would be too expensive or would involve positions too dangerous, too inaccessible or too uncomfortable for humans.

The General Electric TE-9-A transistorized vidicon camera shown in Fig. 1 is designed for such a broad range of applications. It is $5\frac{1}{2}$ in. in diameter and $11\frac{3}{4}$ in. long and weighs just under 9 lb. Inside are 58 transistors, 102 capacitors, 212 resistors, 37 diodes and 3 motors.

The camera is entirely transistorized with the exception of one miniature tube and the vidicon itself. Mechanical and electrical design are integrated to yield a compact, self-contained television camera chain which is rugged and reliable. The camera incorporates circuits such as aperture correction, gamma correction, low-noise video preamplifier, sync generator and keyed clamps to produce a studio-quality picture.

Figure 2 is a block diagram of the electrical circuits within the camera, which is completely modularized and can be totally disassembled with a screw driver. The three circuit boards plug into a common junction panel. The vidicon and the single-unit deflection assembly also plug into this panel; therefore it is possible for a service technician, with limited experience, to locate which of the three circuit boards may be faulty, replace it with a tested board, and return the original board to the shop.

Sweep and Power Supply Circuits

The sweep and power supply circuit board is diagramed in Fig. 3. The basic input voltage is 24-v direct current. The total current drain is $\frac{3}{4}$ amp, making a total power consumption of 18 w. Alternating current, 117 v at 50/60/400 cycles, can also be used. A small external transformer is supplied for this application.

The input voltage is applied to a three-stage transistorized regulator utilizing an emitter-coupled d-c amplifier and a stable Zener reference element. The output of this regulator is a +20-v direct current and is constant to within 0.2 v, over an input range of +21 to +29 v. The regulated +20-v supply is used for several circuits within the camera. Most of its output, however, is used to operate the d-c converter that chops the +20-v direct current into a 40-v, 1-kc square wave, after which it is transformed and rectified to the various voltages required. The +20- and −20-v supplies are used to operate the transistor circuits, the −160- and +340-v outputs supply the vidicon electrodes, and the +160-v supply is used for the tube preamplifier. The +6-v supply is used for the preamplifier and vidicon filaments.

All of these voltages are regulated against *line voltage* variations and, owing to the low impedance of the converter, against *load current* changes. From the diagram it can be seen that the −20-v supply is regulated the second time. This is done to obtain an extremely low a-c bus impedance, since most of the transistor circuits are operated from this voltage.

This board also contains a three-stage focus current regulator. The focus current is sampled across a 100-ohm wire-wound resistor and is compared to a d-c reference voltage. A temperature-compensated d-c amplifier amplifies the resultant error-voltage and controls the effective resistance of the current-passing transistor. In this way the focus current is maintained constant to within 0.2%. This precise regulation is necessary because of the shallow "depth of field" of the electron optics in a vidicon.

A change of several hundred microamperes from the nominal 40-ma focus current will reduce horizontal resolution by 50–100 lines. The horizontal sweep for deflecting the vidicon is of the "switch" type, that is, a step of voltage is switched onto the yoke winding. An approximate sawtooth of current results. However, the small resistance in the yoke winding causes the current to be moderately exponential and for this reason a high Q toroid inductor is placed in series with the yoke to raise the Q of the system. When this is done a horizontal sweep linearity of ±1% is obtained. Only two transistors are required for this

Presented on May 3, 1960, at the Society's Convention in Los Angeles by M. H. Diehl, Studio & Industrial TV Eng., General Electric Co., Syracuse, N.Y.
(This paper was received on September 22, 1960.)



Fig. 1. General Electric TE-9-A transistorized vidicon camera.

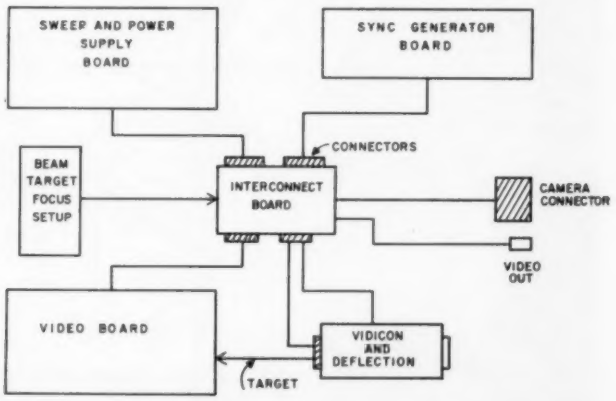


Fig. 2. Electrical circuits of the camera.

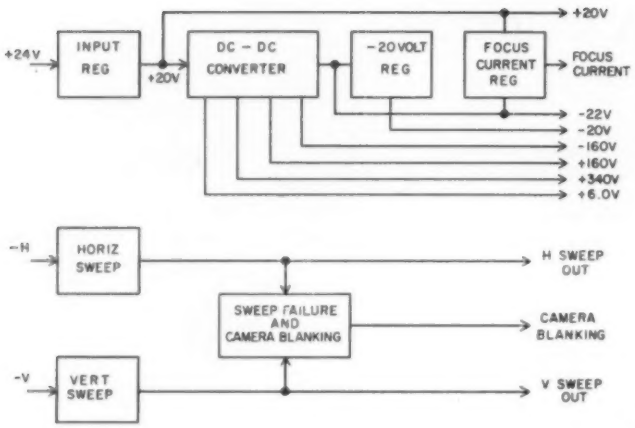


Fig. 3. Sweep and power supply circuits.

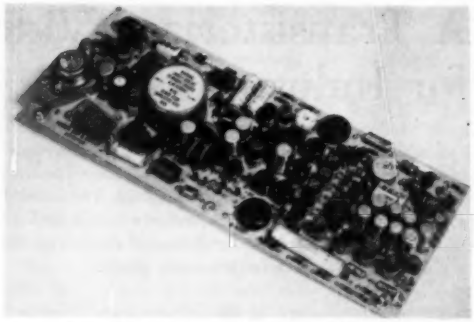


Fig. 4. Mounting of parts of sweep and power supply board.

sweep circuit, which is over 90% efficient and requires no linearity controls. Size is varied by adjusting the d-c voltage supplied to the transistor "switch." The vertical sweep is a conventional sawtooth generator with feedback. A buffer and a Class A output stage is capacitor-coupled to the vertical deflection winding. The circuit has one linearity control and a size control. Electrical centering controls are also included.

The final circuit on this board is an integrated camera blanking and sweep-failure protecting circuit. By clipping part of the horizontal and vertical flyback pulses and adding them together, camera blanking is formed. This waveform is direct-coupled to the vidicon cathode. If either or both of the sweeps should fail, the vidicon will be driven to cutoff. If the protecting circuit itself should fail, an indication is given to the operator, since loss of camera blanking will show up as black retrace lines on the monitor. There are no relays in this circuit and it will blank the vidicon within 0.01 sec after loss of sweep.

The Circuit Board

From the front, the sweep and power supply board shown in Fig. 4 may look like a printed wire board. Actually it is an eyeleted board using small funnel-flange eyelets mounted on an 0.09-in. Textolite board. On the back side of this board the circuit is wired with No. 26 tinned copper wire which is wrapped around the appropriate eyelet.

Where crossovers are necessary, Teflon sleeving is used on one or more of the wires. The electrical parts are inserted in the usual manner on the front side of the board, and the assembled board is soldered automatically. Since both wire and eyelet are pretinned and since the wire is *wrapped and soldered*, a very reliable connection is obtained. Figure 5 is a microphotograph of such a solder joint that has been sawed in half to show how the solder adheres to the various surfaces.

Such a wiring technique has several other advantages: there is less circuit-to-circuit crosstalk (which is particularly important on the video board); a higher circuit density is obtainable since *multiple crossovers* are possible; and the board is much easier to service.

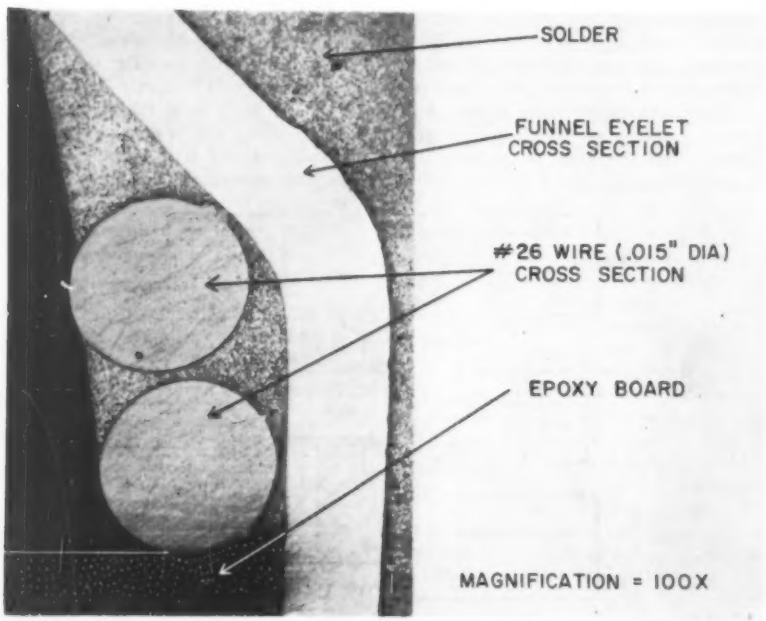


Fig. 5. Cross section of solder joint showing adherence of solder to various surfaces.

Sync Generator

Figure 6 is a block diagram of the sync generator. A 31.5-kc master oscillator triggers a 525:1 frequency divider chain to produce a 60-cycle trigger for starting vertical drive. The master oscillator and all five frequency dividers use a stable blocking oscillator circuit. The reliability of the divider chain depends principally on the free running frequency stability of each oscillator. By locating the RC time base in the emitter circuit and using stable components, the free running stability is within 1 or 2%. Since the highest division ratio used is 7:1, a safety factor of at least 3:1 is obtained. A photograph of the sync board is shown in Fig. 7.

To obtain a wide automatic frequency control (AFC) range and still maintain the safety factor described above, the AFC voltage is applied not only to the master oscillator but also to the frequency dividers. In this way an AFC hold-in range of ±6 cycles is obtained. There is no observable phase modulation in the AFC circuit when the ambient temperature is raised to 65 C.

An important consideration for stable interlace is that the V-drive and V-sync pulses be precisely timed on *both leading and trailing* edges. To do this, the leading edge is "started" by the trigger from the last blocking oscillator as mentioned before. It is "stopped" by a trigger from a previous divider to yield a

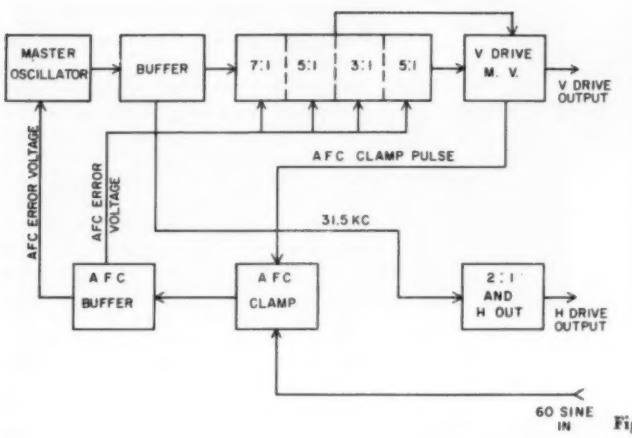


Fig. 6. Sync generator diagram.

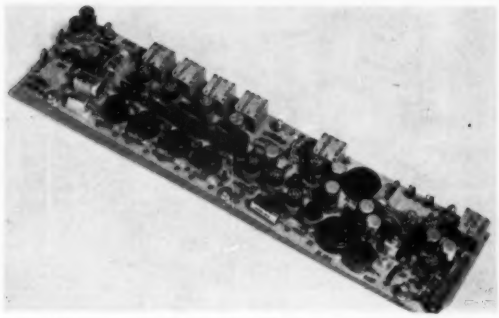


Fig. 7. Arrangement of parts of sync generator board.

V-drive pulse that is exactly 17 lines wide. The total power consumption for the sync generator is 0.3 w.

The Video Board

Figure 8 is a block diagram of the video board. The top row of blocks make up the video strip. The bottom row contains various pulse-forming functions such as blanking mixer and clamp keyer. The video input stage uses a tube to obtain a better signal-to-noise ratio than is possible with a transistor. Not only is the ratio itself better but also the transistor noise, when fed from a high-impedance source such as the vidicon, tends to be loaded toward the lower frequencies and is therefore coarser and more objectionable when viewed on the monitor. Figure 9 shows the circuit of the video input and the high-peaker stage. Operated as a cathode follower, V1 is a 6021 subminiature tube. This is rather unusual for a preamplifier but when followed by a transistor it has several advantages. First of all, the overall input capacity is low, which directly improves the signal-to-noise ratio since less high peaking is required later in the amplifier. Secondly, as the cathode resistor is made larger, the tube microphonics will approach zero whereas the voltage gain will approach unity. To help reduce tube microphonics still further, a half-megohm signal load resistor is used on the vidicon; therefore, a correspondingly high signal *voltage level* is developed at the grid of the pre-amplifier tube. In this way a better signal-to-microphonics ratio can be obtained.

The next stage, a transistor, is driven by the low output impedance of the cathode follower, which provides a near-optimum impedance match and minimizes the noise from this transistor. This transistor also performs the high peaker function. After 20 or 30 kc the response rises 6 db/octave and compensates for the roll-off of the input network.

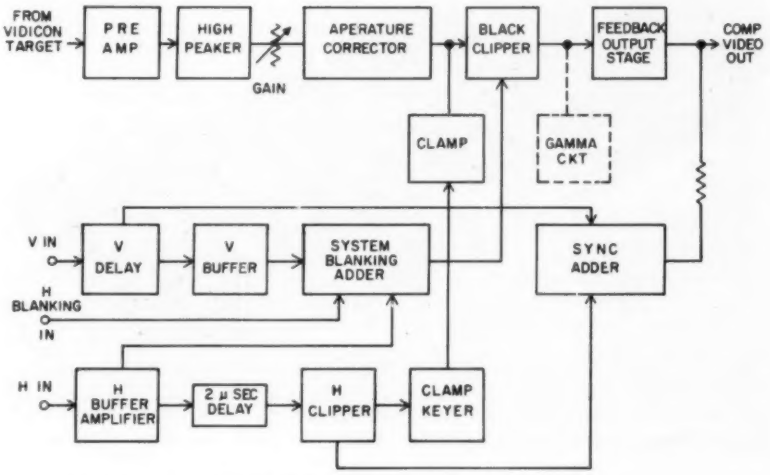


Fig. 8. Video board showing video strip and pulse-forming functions.

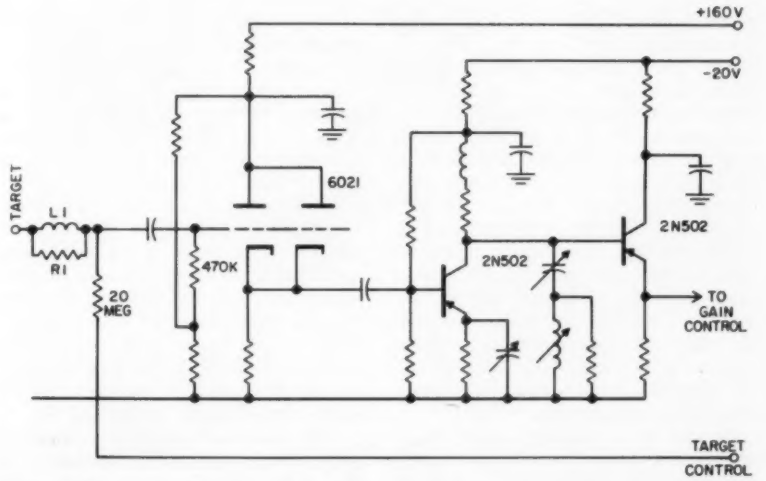


Fig. 9. Circuit of video input and high-peaker stage.

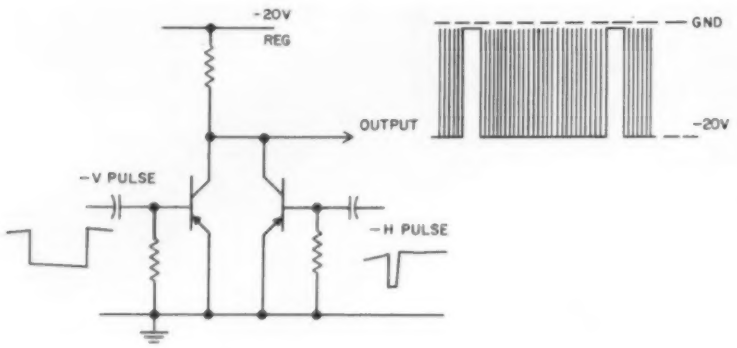


Fig. 10. Transistorized blanking adder.

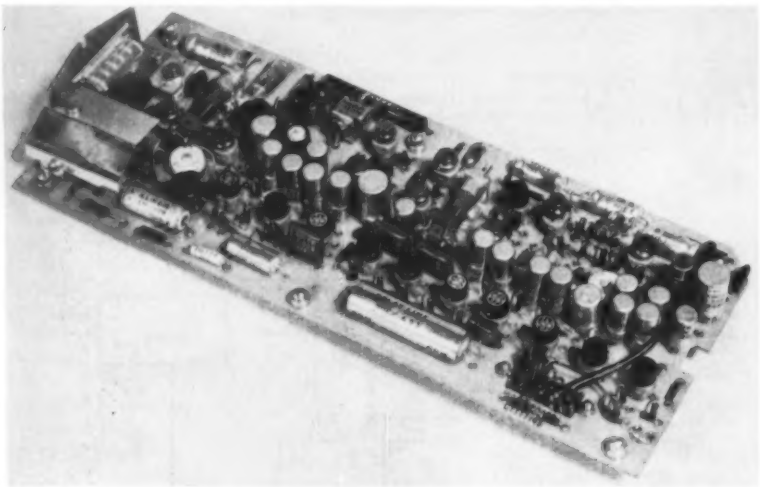


Fig. 11. Video circuit board arrangement.

The high peaker is followed by the video gain control and then by a delay-line type phaseless aperture corrector. This is similar to the vacuum tube prototype except that each input of the difference amplifier is isolated from the delay line by emitter followers. It is noteworthy that the transistor circuit with a peaking ratio of 6 : 1 still provides a low-frequency gain of more than ten.

The keyed clamp circuit, though similar to the tube version, has several important differences. Because the input impedance of a transistor video stage may be several orders-of-magnitude lower than that of a vacuum tube, the clamp-coupling capacitor must be correspondingly larger. In this circuit it is 0.5 μf as compared to 0.001–0.005 μf in tube circuits. This presents no serious problems, however. It only requires that the clamp diodes, the clamp keyer and the video driving impedances all be very low so that the 0.5-μf capacitor may be charged or discharged in a short time by the clamp pulses.

By use of a cascaded *n-p-n—p-n-p* direct-coupled stage, following the clamp, the drift of blanking setup is held to less than 1%.

The load on the black clipper is normally a linear resistance. However, by adding a jumper wire, an optional gamma circuit is energized. This circuit has a slope ratio of 10 : 1 and is used when televising scenes with very high contrast ratios (such as a steel smelting furnace). It has the effect of compressing the contrast ratio so that neither blacks nor whites are lost when the scene is reproduced on the monitor. On many types of material, however, such as printing on a bank statement, it is more desirable to leave out the gamma and thereby increase the contrast reproduced on the monitor.

The video output stage is a transistorized feedback pair with over 20 db of degeneration. It has the usual advantages of stable gain, good frequency response and excellent linearity. Since a closed-circuit TV camera usually feeds a long coaxial cable, a most important advantage of the feedback pair is that it presents a constant 75-ohm source impedance to the coaxial line.

This board contains several forms of pulse circuits such as the clamp keyer, a 2-μ delay line for front porch, plus blanking and sync mixer circuits.

Blanking and Sync Adder Circuits

Figure 10 is a simplified diagram of the blanking adder. This illustrates a circuit function that can be performed more easily with transistors than with tubes. Horizontal and vertical (H and V) pulses are fed into a pair of transistors that have a common collector load. When the left transistor is turned "On" by the negative V-pulse, both collectors are pulled to ground potential. This occurs because the saturation resistance of transistors is much lower than the collector load resistance; therefore H-pulses will not appear at the output during the vertical interval. Because of the low-saturation resistance and the fact that the supply voltage is regulated to within 1%, a very precise output amplitude is maintained. A similar circuit is used to generate camera blanking and the sync waveform.

Figure 11 is a photograph of the video circuit board. Figure 12 shows a waveform photograph of the composite video output at horizontal rate and Fig. 13 shows the output at V-rate. Figure 14 is a photograph of the camera when disassembled.

Mechanical Design

The cylindrical shape of the camera was chosen to provide the maximum strength and ruggedness in a minimum-weight unit which is so designed that all available space is used in the most efficient manner. The front of the camera is an aluminum investment casting that provides a rugged mounting surface for any optical device used with the camera. The base of the camera, also a casting, not only provides a functional base but also gives a clean appearance to the design. The side panels of the camera are aluminum extrusions that provide more than adequate strength with the minimum weight. The aluminum rear panel and the precision slide assembly complete the camera structure. Each part of the structure was carefully chosen to provide maximum utility with minimum space and weight. All aluminum parts in the camera are finished with Iridite, and all brass parts are cadmium plated and then given a Cronak treatment for added protection against corrosion. Stainless-steel parts are all passivated and are used wherever a strong nonferrous material is needed. The camera is enclosed in a heavy, spun-aluminum cover which is protected with a tough, baked vinyl paint.

The cover is removed by loosening two captive fasteners and sliding it off the rear of the unit. The component sides of all chassis are thus exposed to permit circuit checking. All factory adjustments are also accessible when the cover has been removed. An individual chassis can be removed by releasing the captive screws on each chassis and unplugging it.

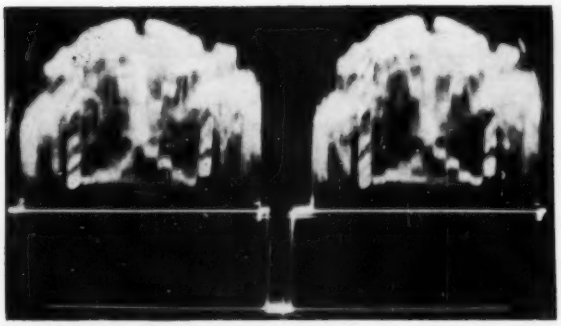


Fig. 12. Waveform of composite video output at horizontal rate.

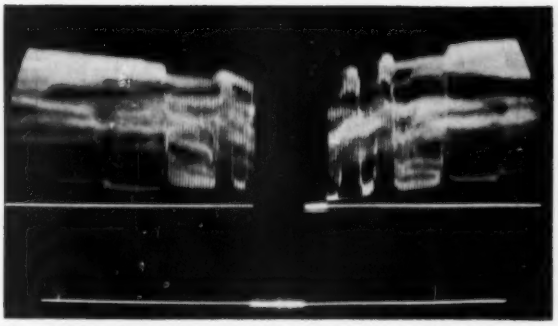


Fig. 13. Waveform of composite video output at vertical rate.

The boards are mounted on special spacers that provide positive electrical ground, space the board uniformly from the mounting surface, rigidly support the chassis, and captivate the hardware. All these features contribute to the ruggedness and reliability of the unit.

Because of the inherent insulating properties of the Textolite board material, it was necessary to provide heat sinks for two of the camera components — the video preamplifier tube and the power regulator transistor. Both of these are provided with aluminum heat sinks that fasten to the outer camera surface and permit the components to operate well below ratings for long, trouble-free operation.

Mounted on each subchassis is a connector that carries the interconnections through a terminal panel to the main camera connector mounted on the rear of the camera. If external accessories are to be used, a junction box is assembled to this connector, providing connections for a zoom lens, a pan-and-tilt unit, and special camera housing accessories, when used.

Optical Accessories

The basic camera construction provides for mounting facilities *internal to the camera* for remote focus, remote iris, remote turret and remote douser units as shown in Fig. 15. Each of these units can be assembled individually or as part of a system that includes the other accessories in any standard camera. Terminals are provided on the connector panel at the rear of the camera for making the electrical connections to these accessories, which can be mounted in the field or at the factory, requiring only a screw driver for their assembly. It should be emphasized that in no case is any driving motor or other driving device located external to the camera. Internal accessories permit the use of many different types of standard lenses in addition to zoom lenses and also permit the use of the douser with any of these lenses. The douser was especially designed to protect the camera from accidental burning due to panning across the sun or other bright objects. Such panning causes a severe burn-in condition on the vidicon tube that usually renders it useless. The rear panel of the camera contains the main camera connector and a Type BNC video connector for use with a separate video cable. It also contains a small removable panel that permits access to the camera setup controls. This, together with the on-off switch, the pilot light and the focusing screw for the vidicon tube assembly, completes the rear-panel control complement.

One-Piece Deflection Unit

An important feature of the new camera is the special deflection assembly designed to meet the particularly high shock and vibration conditions under which the camera must operate. Of single-unit construction, the assembly contains the deflection, focus and alignment coils. The assembly was designed both to be as compact as possible and to accept a vidicon tube in such a manner as to protect it from excessive shock and vibration. The unique method of holding the tube in place is an example of the special measures taken to protect it from shock and vibration. As the tube is inserted into the center of the deflection assembly, it engages a nylon alignment ring at the rear of the assembly. This ring is held in place by a system of spring devices. A beveled nylon insert is then screwed into the *front* of the deflection assembly which compresses the tube against the rear spring devices, giving the tube positive contact and aligning it in the center of the deflection assembly. This provides positive positioning of the vidicon tube during all phases of shock and vibration together with maximum amount of isolation and stability. The complete deflection as-

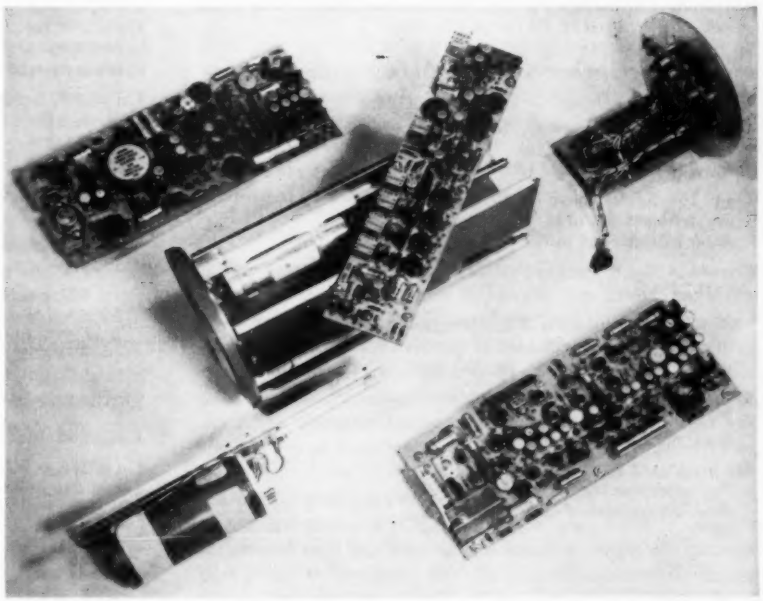


Fig. 14. Disassembled camera.

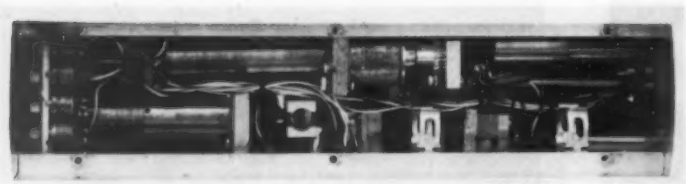


Fig. 15. Mounting facilities for remote focus, remote iris, remote turret and remote douser units.

sembly is then mounted firmly to the ball-bearing slide unit to provide optical focusing of the vidicon. Figure 16 is a photograph of the four-lens turret. Also shown are the iris adapter rings used for remote iris control.

Performance Tests

With the completion of the basic design of the camera, it was necessary to determine whether or not the design criteria with regard to ruggedization had been met. With this in mind, the unit was taken to a rocket test station in upstate New York, where it was used to observe the static test of a medium thrust rocket engine during a 250-sec test operation. The camera for this test was located approximately 25 ft from the rear end of the rocket at the maximum noise angle. The camera was operated continuously during the test and provided a clear picture of all parts of the rocket and of the rocket flame during the test.

A second camera was then tested at several West Coast facilities. Tests were run in close proximity to several missile engines. In each case the camera performed continuously with excellent picture quality and withstood the shock and noise without a protective housing. In one test, the camera was mounted on a bracket 8 ft from the rocket engine. The ambient noise level was estimated to be over 180 db.

Joint quality control and engineering tests have been and will continue to be run on production units to determine any degrading of performance or component failure and to ensure reliable performance in the field. These tests consist of the following variety of environments: (1) temperature, −22 C to +50 C; (2) humidity, 95%; (3) altitude, 70,000 ft; (4) vibration, 0.060 in total excursion 5–55 cycles; and (5) shock, 50 g. All vibration and shock tests are made without benefit of vibration mounts or protective housing.

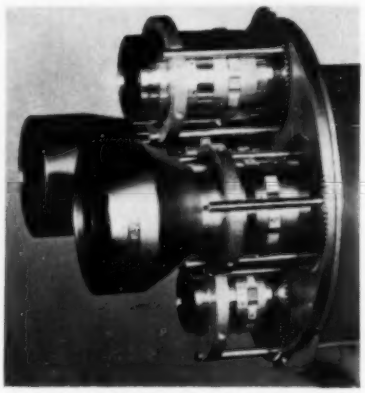


Fig. 16. Four-lens turret of the camera and adapter rings used for remote iris control.

Tests under controlled laboratory high-noise ambients have been conducted at the General Electric Company's Missile and Space Vehicle Department, test facilities at Philadelphia. Tests have been run up to 150-db noise levels over a wide range of frequencies.

Errata

MARCH 1960

"Methods of Appraising Photographic Systems: Part I—Historical Review," by Fred H. Perrin, p. 151–156:

On p. 152, Eq. (1),
For: 0.61
Read: 1.22

On p. 152, 6 lines below Eq. (1),
For: of 0.50 instead of 0.61
Read: of 1.00 instead of 1.22

On p. 154, 5 lines above Eq. (5),
For: lefthand end of x_0
Read: lefthand end to x_2

APRIL 1960

"Methods of Appraising Photographic Systems: Part II—Manipulation and Significance of the Sine-Wave Response Function," by Fred H. Perrin, pp. 237–249:

On p. 240, col. 1, par. 3, line 14,
For: Much above
Read: much below

On p. 243, col. 2, line 5,
For: respresentative of practice
Read: representative of practice

On p. 243, col. 2, 7 lines from bottom,
For: first paragraph
Read: second paragraph

On p. 247, col. 3, par. 2, line 8,
For: Eq. (27)
Read: Eq. (26)

On p. 248, col. 1, line 7,
For: value of ξ
Read: value of ϕ

On p. 248, Eq. 27,
For: tan ξ
Read: tan ϕ

AUGUST 1960

"The Problem of the Unrestored Television Receiver," by Robert J. Nissen, pp. 521–527:

On p. 527, par. 5,
For: Don McClosky
Read: Don McCroskey

OCTOBER

Education, Industry News, "George Lewin . . ."

On p. 756, col. 2, line 9,
For: Patent No. 2,295,971
Read: Patent No. 2,950,971

Focal-Plane Shutters and the Design of High-Frame-Rate Cameras

By SIGMUND J. JACOBS

Operating principles for a new family of rotating-mirror framing cameras which make use of focal-plane shutters are described and examples are given. The basic concept is an extension of the idea of isotransport of image and film, presently found only in moving-film cameras. The rotating mirror and a number of prisms, plane mirrors or concave mirrors are used to produce a sequence of connected frames which move past a fixed slit in the camera at constant velocity. The moving image segments seen through the slit are then relayed to a stationary film by means of a smear camera employing the same rotating mirror. The optics of the smear camera is arranged to stop the motion of each image on the film. As a consequence, a series of stationary images which have been scanned by a focal-plane shutter in a known way are formed on the film. Use of the focal-plane shutter offers the possibility of very precise time definition. Focal-plane shutter characteristics have both advantages and disadvantages in comparison with between-the-lens shutters. One advantage is that multiple slits may be employed. If the images from several equally spaced slits are relayed to independent film areas, it is possible to increase the number of frames and the effective framing speed of a camera without increasing rotor speed or sacrificing f *number. Other possible uses of multiple-slit recording are described.*

THE FOCAL-PLANE SHUTTER (FPS) has been widely accepted for use in still cameras. Its popularity stems from its ability to obtain very short exposure time with high efficiency. In cinematography it is almost universal practice to employ between-the-lens types of shutters. A few high-speed cameras have been developed (isotransport camera) in which focal-plane shutters could be employed to good advantage if their properties were better understood. In some cases such cameras do use these shutters,[1,2] but the effective curtain opening is taken as the frame height. No effort seems to have been made to reduce this opening to improve the ratio of exposure to framing time.*

When framing rates of 10^6 or higher are desired with a purely mechanical-optical system, it has been found necessary to employ a rotating mirror as the means of frame transport. The most successful rotating-mirror framing cameras in this speed range have utilized a principle discovered by C. D. Miller.[3] A 25-frame version designed by B. Brixner[4] is now being marketed by the Beckman & Whitley Co. and by the Cordon Co. In these designs a stationary image formed in the mirror plane of a rotating mirror is viewed by a number of stationary lenses which form stationary images on a film at rest. The images are exposed in sequence by optical between-the-lens shutters. Each shutter is of the moving-slot type; the aperture of the moving slot, an optical image of a fixed stop in the objective lens, is made equal to the aperture of a stop in each final lens to effect maximum shutter speed. The passage of the moving slot past the fixed slot opens and closes the shutter. When reduction of exposure is desired, it becomes necessary in such cameras to reduce the aperture width and thereby increase the effective f number. Thus the total exposure of a given frame varies as the square of the exposure time. If a camera was to be constructed with an optical focal-plane shutter (OFPS), the exposure would be proportional to the exposure time.

The first literature reference to an OFPS is that of Anderson and Smith.[5] These authors also described a means of obtaining several frames in sequence, based on their principle. The method was somewhat cumbersome and it appears that no attempt was ever made to construct a camera to their design.

In this paper the application of focal-plane shutters to cinematography is considered in general terms, and then the design of FPS cameras based on a rotating mirror is discussed. It will be demonstrated that the FPS can significantly reduce the exposure time for a given framing time while retaining both the aperture and the precision of timing.

Operating Principles

Focal-Plane Shutters in Framing Cameras

Basically, in FPS framing cameras a sequence of images would be projected, one following the other, into the plane of a film and a slit would travel past this series of images at constant velocity V to expose each element of the image series for a time $t_e = w/V$ where w is the slit width. The framing time would be $t_f = x_p/V$ where x_p is the distance between consecutive images. Or, reversing these conditions, the slit might be considered to be at rest as in a smear camera while the film and the train of images move past it at equal velocities as in isotransport cameras. Of course, a real train of images in unnecessary. As long as the image is cyclically formed just prior to reaching the slit and remains until it has passed the slit, the result on the film continues to be a continuous train of images.

* Recently Wollensak announced the use of narrow slits for a Fastax Camera. The frame height is reduced to one-third the interframe spacing when these slits are used. No mention is made of the relation between time and image positions when the slits are used.

Presented on October 20, 1960, at the Fifth International Congress on High-Speed Photography by Sigmund J. Jacobs, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md. The work reported here was supported in part by the Atomic Energy Commission through the University of California Lawrence Radiation Laboratory, Livermore, Calif.

A number of moving-film cameras already exist in which a sequence of images is made to move past a focal plane in synchronism with a moving film. Most familiar is the rotating-prism camera as exemplified by the Eastman High Speed[6] and the Fastax cameras. Moving-lens cameras which accomplish this purpose have been described by Jenkins[7] and by Wyckoff.[8] Multifaced rotating mirrors have been used for this purpose by Suhara,[9] by Zeiss[10] and more recently by Beckman & Whitley in the Dynafax.[11] Scophony[12] has built a camera in which one mirror face is used for each image. Miller[1] and Miller and Scharf,[2] have described isotransport cameras based on a series of right-angled prisms or their equivalent to provide image repetition and transport. Many of these cameras could be converted to narrow-slit FPS cameras merely by inserting the slit at an appropriate plane.

Figure 1 illustrates a simple rotating-drum camera which can be used for comparison of focal-plane and between-the-lens shutter action. It consists of a single rotor on which both the film and a series of equally spaced lenses are located. An image of the subject is located with its center on the axis of rotation of the drum. If a fixed rectangular aperture is located just to the right of the lens circle and rectangular apertures are placed on each lens, the combination acts as a between-the-lens shutter. Alternately, if a rectangular aperture is placed very close to the film plane, the camera becomes a focal plane shutter type.

The sequence of frames in a framing camera can be considered to be samples of an event in which x and y represent the same space coordinates from frame to frame and t represents the time. If we neglect time changes of intensity in the subject, a camera with a between-the-lens shutter is characterized by the condition that all values of x and y in the frame see the same relative intensity I as a function of time. Figure 2 shows the intensity-time plot for a camera such as that in Fig. 1 employing equal rectangular openings in the lens plane, one fixed, the other moving at constant velocity. A sequence of n frames may be considered to be n samples of the intensity of all x,y points in the frame at n mean times, each time having a spread given approximately by the exposure time.

The sampling of x, y and t in a focal-plane shutter camera is different. For a slit parallel to the y axis, all values of y for a given x see the same relative intensity-time relation. At any point, x, this is essentially a square-step jump to I_{max} followed by a jump to zero after some

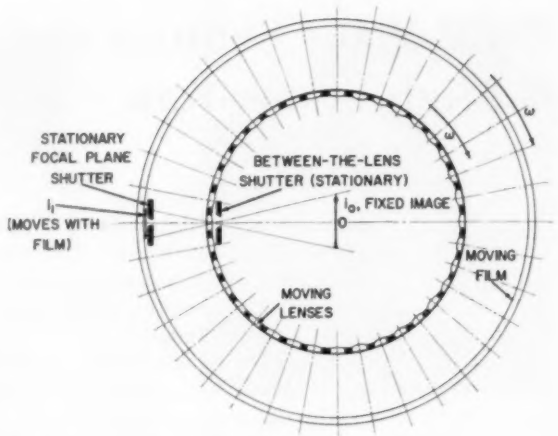


Fig. 1. Rotating-film and lens camera.

time, t_e. Figure 3 characterizes the FPS camera in a plot of x against t. The relative intensity vs. time for one value of x can be represented by the diagram shown in the upper half of Fig. 3. In the frame of an FPS camera the mean time of exposure is seen to be dependent on the x position in the frame. This leads to a certain amount of time distortion in the frame. At first glance this might be considered undesirable. However, time at any point, x, is precisely determinable so that insofar as sampling the x,y,t space, n frames represent n samples of any point x,y at given mean times and with a time spread t_e. For data acquisition, the result is essentially the same as before except that we may now alter the time spread by varying the slit width without affecting the aperture of the lens forming the image. By using very narrow slits the focal-plane type camera can be made to serve some of the precise functions of the smear camera. It can have smear-camera precision coupled with the space coverage of the framing camera If the interframe distance established on the film is x_F and the slit width is w, the ratio of exposure to frame time can be given as $t_e/t_F = 3w/x_F$. For image velocity, V, the frame speed (frames per unit time) is V/x_F

Multitrack Recording With Focal-Plane Shutters

A novel feature of FPS cameras is that this shutter type permits the use of multiple images or multiple slits to increase the effective framing speed as well as the total number of recorded frames without changing either the size or speed of the rotating mirror. The principle of

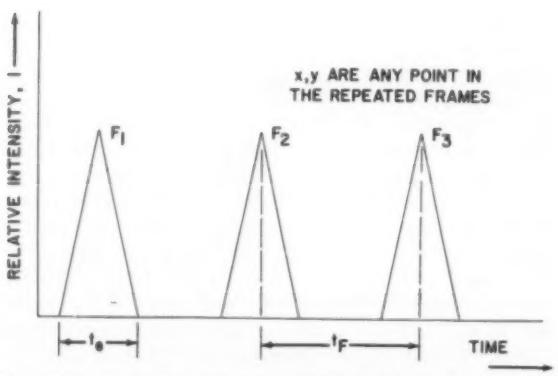


Fig. 2. Characteristics of between-the-lens shutter.

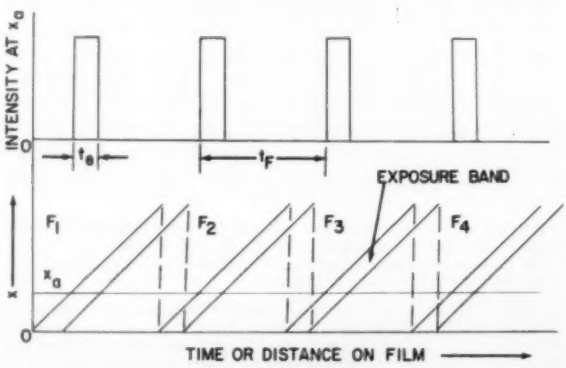


Fig. 3. Characteristics of focal-plane shutter.

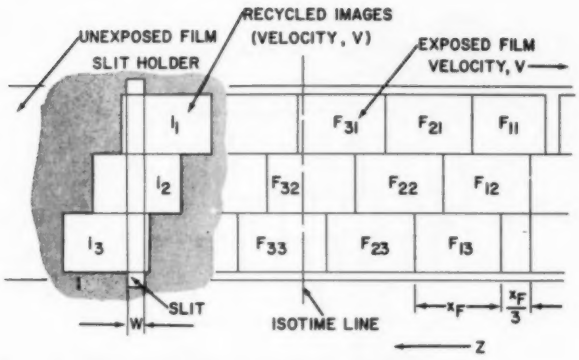


Fig. 4. Multiple-track recording.

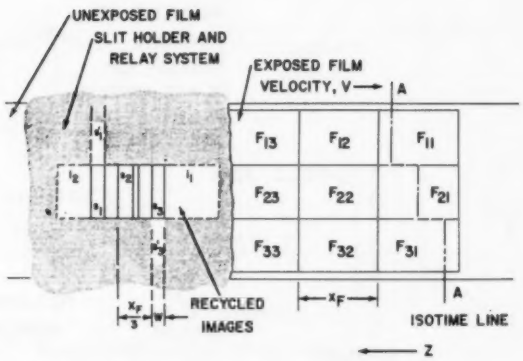


Fig. 5. Multislit multiple-track recording.

multiple-image recording is illustrated in Fig. 4, where moving images i_1, i_2, and i_3 are projected one above the other onto a slit. It is assumed that these images will be reformed cyclically so that each appears to the slit as a train of images spaced by a distance x_F. The images are offset by a distance $x_F/3$. Behind the slit a film is assumed to move at a velocity, V, equal to that of the moving images. The result, as illustrated, is the formation of three rows of frames on the film. Any vertical line drawn through the frames is a line of constant time. We may define the exposure time for any point in the frames as $t_e = w/V$. The total time to expose one frame such as F_{11} is x_F/V. The framing time, however, can be more properly considered as the time to repeat the exposure of a given point, x, common to all the frames. This is $t_F = x_F/3V$.

An alternate approach to the formation of multiple tracks of images is illustrated in Fig. 5 for three tracks. Three slits, s_1, s_2 and s_3, are placed side by side and spaced a distance $x_F/3$. By optical means two of the slits, s_1 and s_3, are displaced so that they appear to the film to be located at s_1' and s_3'. It is now necessary to recycle two images, i_1 and i_2, side by side so that the film behind each slit sees a continuous train of images. The result on the film is three rows of images, each frame in each row directly below the next. An isotime line is now any line parallel to the stepped line AA. The effective framing time and the exposure time are the same as before. In both of the above examples $t_e/t_F = 3w/x_F$ and can be made as small as desired by the choice of w.

The Design of Rotating-Mirror FPS Cameras

The FPS camera has been illustrated in its simple form by considering the moving film, moving images and slit in a single plane, the focal plane of the image. In a rotating-mirror system it is desired that the film remain stationary. Consequently a stationary sequence of images must be projected to the film and the slit must appear to move continuously past the film. This can be brought about by locating a fixed slit in an intermediate image plane and by designing an optics system so that the rotating mirror first causes the recycled images to pass the slit. The images passing through the slit are then reprojected by a second lens using the rotating mirror a second time to cancel the translation motion so that the images of the subject are brought to rest. Such systems may be conveniently analyzed in another way. The second projection via the rotating mirror may be considered as projections of points on the film into the slit plane. If this part of the optical system is designed to give an apparent film motion at the slit plane equal to that of the moving images, then the final images on the film will in turn be stationary.

Camera Designs

Rotating-mirror FPS cameras may be considered to consist of two sections. The first provides a means for causing a sequence of images to pass a fixed slit or a number of slits. The second, essentially a smear camera, provides for relaying the slit images and the images seen through it to a stationary film in such a way that the image of the subject is brought to rest on the film. The accomplishment of these ends will be described for a number of intermittent-access cameras, that is, cameras in which the sequence of images appears only during a fraction of the period of rotation.

Design No. 1, Preformed Image Field

This design is based on a modification of the OFPS of Anderson and Smith.[5] Figure 6 shows the original design used by these authors for obtaining one image. In this design the subject is brought to focus on a mirror at C. The reflection off the mirror is projected by means of the rotating mirror at O and a lens, L_2, to form a stationary image, i_2, on the film. A single image is formed. We may note that if a second mirror is placed on the arc at radius, r, only a double exposure results.

In order to obtain a sequence of images, some other

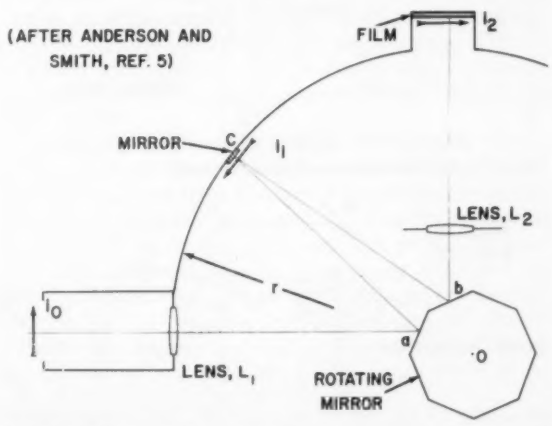


Fig. 6. Optical focal-plane shutter.

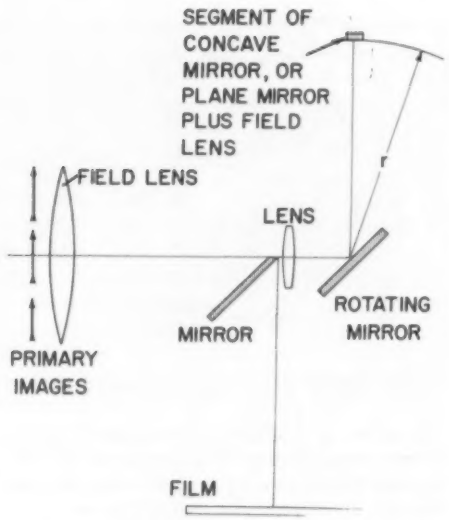


Fig. 7. Camera with preformed field.

means must be used. Figure 7 shows a variant of the principle which employs but one reflecting face on the rotating mirror. To obtain a sequence of images on several lines, the primary image can be made up of a prearranged group of images as shown in Fig. 8. The group shown consists of five rows of images in approximately eight columns. The columns are offset by one-fifth the frame spacing on a given row. This array could be produced by employing one lens to form each image, each lens being located so as to reproduce the field of the subject except for a small parallax error.

An improvement of the camera of Fig. 7 appears in Fig. 9. Two sides of a thick rotating mirror are now employed. This prevents crosstalk from lens L_1 to lens L_4 and the film. A real slit is now located so that the light passes through it. The optical path behind the slit is boxed in so that the amount of stray light reaching the film from surfaces other than the slit is greatly decreased. If this camera were to be constructed with L_1, L_2, L_3 and L_4 of 20-in. focal length and with a rotating mirror 2

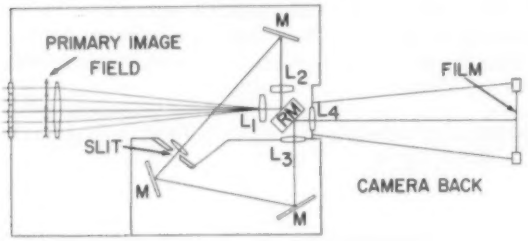


Fig. 9. Optical focal-plane shutter camera.

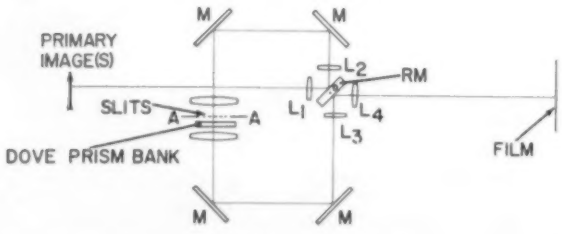


Fig. 10. Focal-plane camera (dove-prism type).

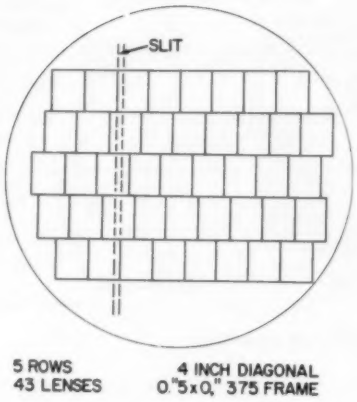


Fig. 8. Image layout, 40 frames.

in. wide, the image field of Fig. 8 could be recorded at 2×10^6 frames/sec using a modest rotor speed of 600 rps. The f-number of the camera would be approximately $f/12$. A 4 by 5-in. plate back would be used. Image size could be traded for f number by merely changing the camera back, i.e., L_4 and the film distance. If L_4 were reduced to 10 in., the f-number could be reduced to $f/6$ with images 4.5 by 6.0 mm.

Design No. 2, Use of Dove Prisms

A disadvantage of the design of Fig. 9 is that the entire image field must be preformed by individual lenses. By means of the arrangement of Fig. 10, the number of primary images can be reduced to equal the number of rows desired on the final film. In this design, dove prisms are used in the slit plane A-A, one prism behind each of n slits. If the image spacing is to be x_p, the slits and prisms are spaced $x_p/2$. If we consider using five primary images, these would be arranged in a column normal to the plane of the figure. The images would be offset, one to the next, by a separation of $x_p/10$. If nine slits are used, we are assured of 40 equally spaced time samples for each point in the image field. An even number of

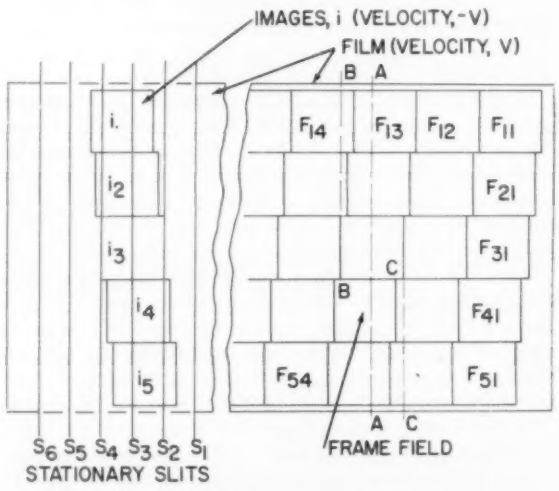


Fig. 11. Equivalent action of dove-prism camera.

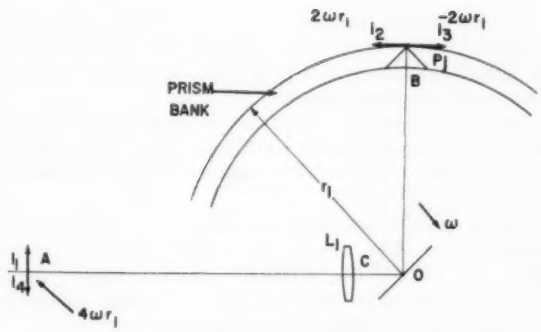


Fig. 12. Schematic of prism-type image sequencer.

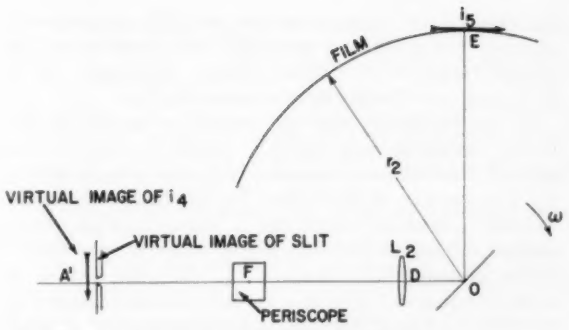


Fig. 13. Smear camera to stop images on film.

plane mirrors, M, must now be used in the ray path to result in a stationary image on the film.* A property of this design is that the effective framing rate is doubled. This camera would therefore have a frame rate of 4×10^6/sec if lenses and rotor speed were chosen to be the values previously cited.

Figure 11 shows the primary image layout and the final frame array for a 5-track, 6-slit system. In the frame array it can be shown that there are always two vertical lines on each row of images which represent a given value of time. Line AA is one and lines BB and CC represent the second for a specific time. The analysis to establish the time at each point in the field will not be undertaken, however, in this paper. The problem is solved by considering these images to be moving to the right while the film is moving to the left at the same velocity past a set of stationary slits. We may point out that if the slits were very narrow the dove prisms could be omitted. The frames would still appear intact, being formed now by what might be termed image dissection followed immediately by a restoration of the relative positioning of image sections on the film. In the prismless camera, resolution in the x direction would be determined by the slit width as is the case in many dissector cameras such as the O'Brien-Milne Camera.[14]

Design No. 3, Use of Right-Angled Prisms

The designs already considered have used an image field which has been limited in the direction of slit scan by the distance that could be sharply resolved behind a fixed lens. This limits the film area to about 4 by 5 in. or 20 sq in. We now consider designs in which this restriction is removed. The first employs right-angled prisms in a rotating-mirror analog of the drum camera described by Miller.[1] The principle of the image-sequence former (sequencer) for this camera is illustrated in Fig. 12. A rotating mirror at O revolves with an angular velocity, ω. Right-angled prisms are located with their apices on a circle of radius r_1. An image of the subject i_1 is located at A. A moving image i_2 is caused to sweep past the prism set by the rotating mirror. A reflected image i_3, then appears to move past each prism at a velocity of $-2\omega r_1$. This image is seen by lens L_1 which forms an image i_4 at A. The image i_4 moves clockwise about the center of L_1 at a linear velocity of $4\omega r_1$ if all images are of equal size. If the prism hypotenuse is of length $x_F/2$ (where x_F is the image width), a continuous train of images i_4 is formed at A. A slit would be located at A through which the image is projected to the film.

Figure 13 shows the optical arrangement for forming stationary images on the film. A periscope located at F behind i_4 of Fig. 12 drops the image path to a lower deck represented as Fig. 13. A virtual image of i_4 and of the slit now appears to be at A'. If r_2, the film radius, is made equal to $2r_1$ and if $A'D = DOE$ (E being any point on the film), stationary images i_5 will be formed on the film. The image of the slit or FPS meanwhile traverses the film at the constant velocity $2\omega r_2$.

The above discussion and the illustations have been simplified to one specific case; that is, all images are of equal size. Any radius r_2 is permissible if the condition $r_2 = 2Mr_1$ is satisfied (M is the image magnification i_5/i_4). In practice, field lenses must be used in front of each right-angle prism and at the image plane of i_4. Multitrack operation is possible within limits* by using i_0 as a multiple image or by using multiple slits with appropriate mirror systems to displace the resulting images so that lens L_2 sees the images as in Fig. 4 or 5.

Design No. 4, Use of Plane Mirrors

The preceding design based on right-angled prisms presents some very practical problems. The most unattractive feature is that the number of image-forming lenses, field lenses and mirror surfaces is so great that both image quality and intensity must be relatively poor. We have therefore looked at simpler approaches to the solution of the image-sequencing part of an FPS camera. A closer look at the original paper of Anderson and Smith has suggested one solution in which plane mirrors are employed to recycle the moving images. The method may be described with the aid of Fig. 14.

The optical arrangement consists of a rotating mirror which revolves about O with angular velocity ω. On an arc of radius r_1 are a number of plane mirrors spaced at a center-to-center distance x_M. The jth mirror is shown at B. A lens, L_1, images the primary image i_0 to form an image i_1 at C. This image is formed by light traversing the path $AOBOC$, that is, by two reflections off the rotating mirror and one off M_j. If we take the distance OC as b, it can be shown that i_1 has a linear velocity of $4\,\omega(r_1 + b)$. To an observer on

* In this and in the previous camera described, the condition for stopping the image on the film is that the optical distance from L_2 to the slit plane equal the optical distance from the slit plane to L_3. In addition an odd number of reflections in the plane of the drawing must be provided by fixed mirrors. The dove prisms supply the 5th reflection to satisfy the latter condition.

* When multiple images or multiple slits are used with the right-angled prism system, images can no longer appear as a continuous train on all tracks. The analysis to show this is beyond the scope of this paper.

the axis OA, an image is seen on this axis irrespective of whether b is positive or negative. We therefore see the special case $b = -r_1$ which places the image i_1 at B is the case described by Anderson and Smith.

It can be shown that the width, x_1, of i_1 is related to the mirror spacing by $x_1 = 2x_M(r_1 + b)/r_1$ if it is desired that a train of touching images is to be formed at C. The camera is completed by locating a slit at C, behind i_1, and by employing a smear-camera section similar to that of Fig. 13. If the image on the film is made dimensionally equal to i_1, the film radius, r_2, must be equal to $2(r_1 + b)$ to obtain stationary images on the film. In Fig. 15 one method of locating the principle components of the camera is shown.

Design No. 5, Concave-Mirror Camera

A second FPS camera which employs a minimum number of optically simple components in the ray path can be constructed with concave mirrors as the image sequencer. Figure 16 shows the operating principle of the sequencer. When spherical concave mirrors are used as image formers, the optimum point for the best image resolution is at the center of curvature of the mirror. For this reason the primary image i_0 and the moving image i_1 are located near the same point, A, a

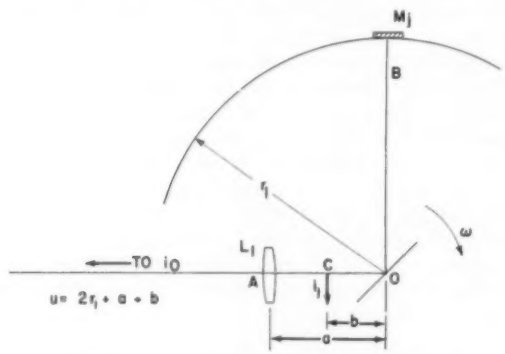


Fig. 14. Schematic of plane-mirror type image sequencer.

distance a from the rotating mirror. The concave mirrors are located on a circle of radius r_1 such that $r_1 + a = r_M$, the radius of each concave mirror. It is found that the velocity of i_1 is $4a\omega$. If $a = r_1/2$, the velocity is $2r_1\omega$. This motion can be compensated on a film track located a distance $r_2 = r_1$ from the rotor if the dimensions of the film image and i_1 are equal. A camera based on this principle is presently under construction at the Naval Ordnance Laboratory. It is described more fully in the following paper.[15]

Discussion

The focal-plane shutter has been discussed and shown to have the following useful characteristics for framing cameras.

(1) The exposure of each elemental area of the frame sequence is a square step function. The time spread of exposure is easily controlled by choosing the width of the curtain aperture. The ratio of exposure time to framing time can be made as small as desired, being limited only by the optical resolution of the camera system.

(2) Modifying the ratio of exposure time to framing time does not affect the optical aperture of the camera.

(3) Multitrack framing can be profitably utilized by using more than one primary image with a single slit or by using a multiple-slit system which produces multiple images with known phasing.

(4) The exposure of each frame is not simultaneous for all points in the frame but instead the time of exposure is a known linear function of position in the direction of slit travel.

When an FPS camera is used for data recording, the position-time data can be as precise or more precise than that of a between-the-lens shutter type camera. For playback each frame would exhibit time distortion because of the nonsimultaneous exposure.

A number of designs have been considered for constructing rotating-mirror FPS cameras. The simplest and probably the most feasible are: (a) a design which uses dove prisms to recycle the images and record them on approximately 20 sq in. of film; (b) designs using either plane mirrors or concave mirrors to recycle the images for recording on approximately 200 sq in. of film. We estimate that the latter cameras can be built with multitrack recording to write about 300 frames of 35mm proportion at framing speeds up to 5×10^6/sec. These cameras would operate at an aperture of about $f/20$.

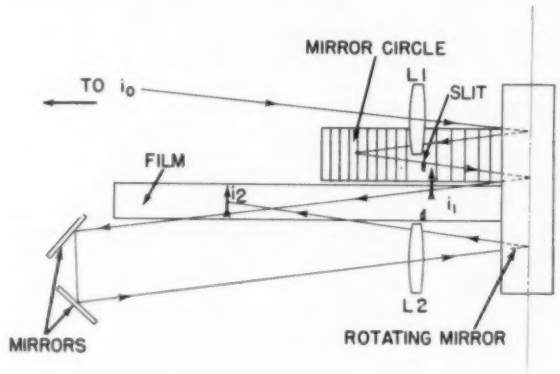


Fig. 15. Plane-mirror camera.

Minimum resolved time should be about that of a good rotating-mirror smear camera. This is approximately 10^{-8} sec.

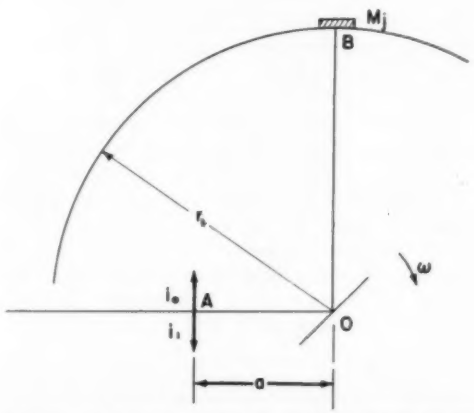


Fig. 16. Schematic of concave-mirror type image sequencer.

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Résumé

Les obturateurs focaux et la construction des caméras à haute cadence d'images

SIGMUND J. JACOBS, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

L'auteur explique, avec de nombreux exemples, les principes de fonctionnement d'une nouvelle série de caméras multi-images à miroir tournant qui utilisent des obturateurs focaux. Le principe de base est une extension de l'idée d'isotransfert de l'image et du film, qu'on ne trouve actuellement que dans les caméras cinématographiques. On utilise un miroir tournant en combinaison avec plusieurs prismes, miroirs plans ou miroirs concaves pour produire une série d'images reliées qui défilent devant une fente fixe de la caméra à une vitesse constante. Les segments d'image mobile vus par la fente sont ensuite transmis à une pellicule fixe au moyen d'une caméra maculeuse qui utilise le même miroir tournant. Le système optique de la caméra maculeuse est disposé de manière à arrêter le mouvement de chaque image sur la pellicule. Il s'ensuit qu'une série d'images fixes qui ont été "explorées" par un obturateur focal d'une manière connue se forme sur la pellicule. L'emploi de l'obturateur focal offre la possibilité d'un réglage très précis du temps.

Les caractéristiques des obturateurs focaux ont à la fois des avantages et des désavantages par rapport aux obturateurs du type entre lentille. Un avantage est qu'on peut employer des fentes multiples. Si les images provenant de plusieurs fentes également espacées sont transmises à des zones indépendantes de pellicule, il est possible d'augmenter le nombre d'images et la cadence effective d'images d'une caméra sans accélérer le miroir tournant et sans sacrifier l'indice-f. L'auteur décrit d'autres emplois possibles de l'enregistrement à fentes multiples. Ces travaux ont été en partie sous l'égide de la Commission d'Energie Atomique avec la participation du Laboratoire de Radiation Lawrence de l'Université de Californie, Livermore, Californie.

Zusammenfassung

Schlitzverschlüsse und der Entwurf von Kameras für hohe Bildgeschwindigkeiten

SIGMUND J. JACOBS, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Es werden die Betriebsgrundsätze und Beispiele angeführt, betreffend eine Gruppe neuer Bildreihenkameras mit rotierenden Spiegeln und Schlitzverschlüssen. Die Grundidee beruht auf dem Isotransport von Bild und Film wie man ihn gegenwärtig nur bei Kameras mit bewegtem Film kennt. Der rotierende Spiegel und eine Anzahl von Prismen, Plan- und Konkavspiegeln werden verwendet, um eine Reihe verbundener Aufnahmen zu erzeugen, die an einem stationären Schlitz in der Kamera mit konstanter Geschwindigkeit vorüberziehen. Die durch den Schlitz gesehenen sich bewegenden Bildsegmente werden dann mittels einer "Schmier"–Kamera die den gleichen Rotor-Spiegel hat, auf einer stationären Film übertragen. Die Optik den Schmierkamera ist so angeordnet, dass auf dem Film die Bewegung jedes Bildes gestoppt wird. Der Gebrauch des Schlitzverschlusses (in der Bildebene) gibt die Möglichkeit sehr genauer Zeitdefinition.

Die Charakteristiken des Schlitzverschlusses haben — im Vergleich mit dem Verschluss zwischen den Linsen — sowohl Vor-als auch Nachteile. Ein Vorteil ist der, dass mehrfache Schlitze angewendet werden können. Wenn die Bilder von verschiedenen in gleichen Abständen von einander liegenden Schlitzen auf unabhängige Filmabschnitte übertragen werden, lässt sich die Anzahl der Aufnahmen und die wirksame Bildgeschwindigkeit einer Kamera steigern ohne die Geschwindigkeit des Rotors zu steigern oder die relative Öffnung zu vermindern. Diese Arbeit wurde teilweise durch die Atomic Energy Commission durch das University of California Lawrence Radiation Laboratory in Livermore, Kalifornien ermöglicht.

Edit. Note: Two camera models based on this paper were exhibited at the meeting. One was a working model of the dove prism camera; the second was a layout model of the concave mirror camera.

A Rotating-Mirror Framing Camera With Multiple Focal-Plane Shutters

By SIGMUND J. JACOBS, J. D. McLANAHAN and P. F. DONOVAN

In the preceding paper by Jacobs, a new family of rotating-mirror framing cameras has been discussed. This paper describes a camera in this family in which a number of concave mirrors are used with a single rotating mirror to create a connected sequence of images which pass several slits that act as focal-plane shutters. The images seen through the slits are relayed to form separate rows of frames by means of a smear-camera arrangement. By combining 36 concave mirrors with six properly phased slits, a total of 216 frames can be recorded in approximately $\frac{1}{8}$ revolution of a rotating mirror. The camera now being constructed at the Naval Ordnance Laboratory will use two mirrored faces, 6 by 2 in., of a rectangular rotating mirror. At the anticipated rotor speed of 600 rps approximately 10^6 frames/sec will be attained. Each frame will be about 0.75 in. high and 1.0 in. wide. It will be possible to vary the shutter-to-framing-time ratio from about 0.5 to about 0.02 by varying the width of the slits used in the camera. The effective aperture will remain fixed at about f/22.

THE PROPERTIES of focal-plane shutters (FPS) as they pertain to framing cameras were described in the previous paper by Jacobs.[1] In addition, a number of designs were discussed in which the FPS was incorporated into high-speed rotating-mirror framing cameras. One of the designs employed a number of concave mirrors to produce a connected sequence of image frames which appear stationary on a film and which appear as if scanned by a slit in the film plane.

A camera based on this design principle is presently being constructed at the Naval Ordnance Laboratory. The principal features of this design will be discussed. This camera will contain about 36 concave mirrors and will employ multiple-slit recording through six slits. It will write six tracks of images on two 70mm film strips to give a total of about 216 frames with approximately 1 μsec frame interval. Each frame will be approximately 1 by 0.75 in. The effective aperture of the camera is about $f/22$. The camera is of the synchronized type. Images are produced for approximately one-eighth the rotor cycle. Because two mirrored faces are used, the sequence of images is repeated twice per cycle. The continuous-access version of this camera will be considered at a later date.

The Camera Layout

Figure 1 shows the essential components of the camera when three shutter slits and one film drum are employed. Light rays follow the path shown. The subject is viewed by lens L_1 to form an image i_0 in a framing window. Behind this window is a field lens (not shown) which forms an image of L_1 at the concave-mirror bank. The rays passing from i_0 are reflected by the rotating mirror to each of the concave mirrors in sequence. Returning rays from the concave mirrors via the rotating mirror form images in the slit plane. These images move past the slits as the mirror rotates. A 45°, 90° parallelepiped prism unit* separates the images seen through the three slits so that they appear one above the other. The unit will be discussed in greater detail in a later section.

The rays forming the three images seen through the slits are relayed by mirrors to lens L_2. They continue to the rotating mirror and are then reflected to form three images on the film. A field lens (not shown) is located at the slit plane. In the stopped position of the rotating mirror as sketched, images have been formed by all concave mirrors to the left of the concave mirror receiving the beam. This mirror has formed partial images. The instantaneous images of the optically displaced slits are shown in their relative position on the film. The section of the camera from L_1 through the parallelepiped prisms will be called the image sequencer and the section beyond will be called a smear camera. The terms describe the respective functional purposes.

The Concave-Mirror Sequencer

The principle of forming a sequence of moving images by using concave mirrors was briefly described in the preceding paper.[1] Figure 2 shows the elevation and plan of the camera of Fig. 1 for forming one image track. The plan view shows the essential components that constitute the sequence unit. The primary image, i_0, is formed at A, at a distance a from a rotating mirror located at O. On the arc of a circle of radius, r_1, are n spherical concave mirrors with a spacing of X_M on the circumference of the circle. The j-th mirror M_j is shown at B. With a radius of curvature for each concave mirror of $R = r_1 + a$, these mirrors in turn form images i_1 at A when the rotating mirror is appropriately oriented. When the rotor revolves at an angular velocity ω, a sequence of moving images appears at A. (We consider ω to be the angular velocity in radians/sec. The rotor speed in cycles/sec. is therefore $\omega/2\pi$.) Each image has a linear velocity of $4a\omega$. By making $a = r_1/2$, the linear velocity becomes $2\omega r_1$.

If a slit is placed in the vicinity of A, a continuous train of images will traverse this slit provided the width of each image is the same as the concave-mirror spacing.

Presented on October 20, 1960, at the Fifth International Congress on High-Speed Photography, Washington, D.C., by Sigmund J. Jacobs (who read the paper), J. D. McLanahan and P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md. The work reported here was supported in part by the Atomic Energy Commission through the University of California Lawrence Radiation Laboratory, Livermore, Calif.

* The prisms in this unit are generally referred to as "rhomboid prisms."

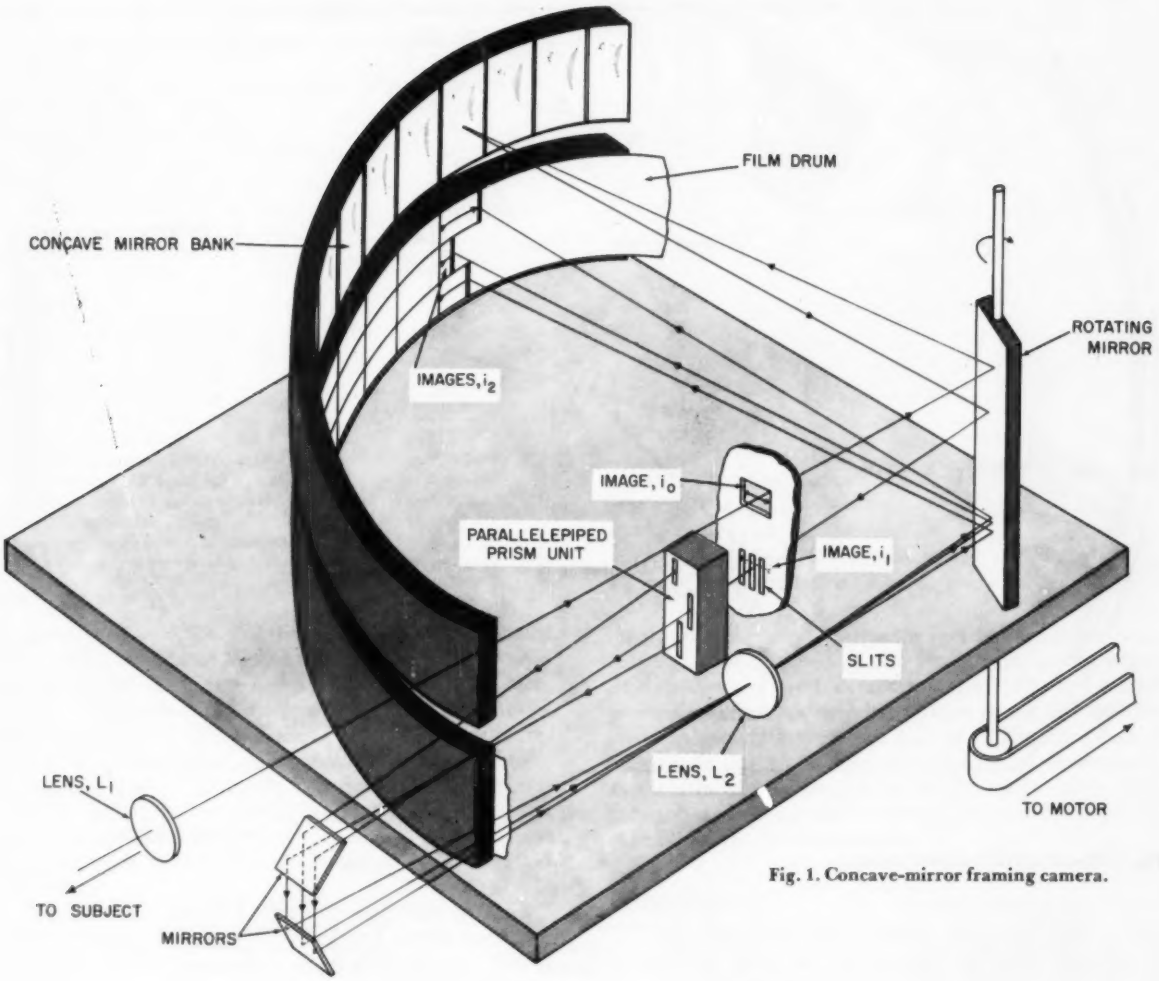


Fig. 1. Concave-mirror framing camera.

The images seen through the slit are subsequently reprojected as shown in the elevation view to form a stationary image sequence on a stationary film.

The images will be brought to rest on the film if i_1 and i_2 (Fig. 2) are of equal dimensions, if the film drum radius is r_1 and if the number of mirror reflections between i_1 and L_2 in the plane of the plan view is odd. (We may note that the two mirrors in the beam path in the elevation are equivalent to one mirror reflection in the plane of the plan view.)

The restriction $r_1 = 2a$ is not a necessary limitation on the camera but rather one of convenience. It is desirable that both object and image be placed near the center of curvature of the mirror when spherical mirrors are used, since this center is the point of maximum resolution. If elliptical mirrors are used, the object may be placed at one principal focus and the image at the other. Images can be stopped on a film of radius other than $r_2 = r_1$ provided the image magnification from i_1 to i_2 is appropriately adjusted. The general condition for both stopping the final image and obtaining a continuous train of images is

$$X_F/X_M = r_2/r_1$$

where X_F is the final image spacing.

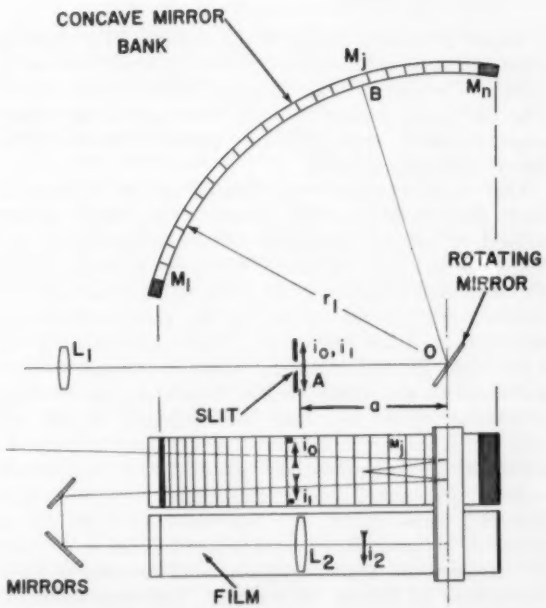


Fig. 2. Concave-mirror sequencer.

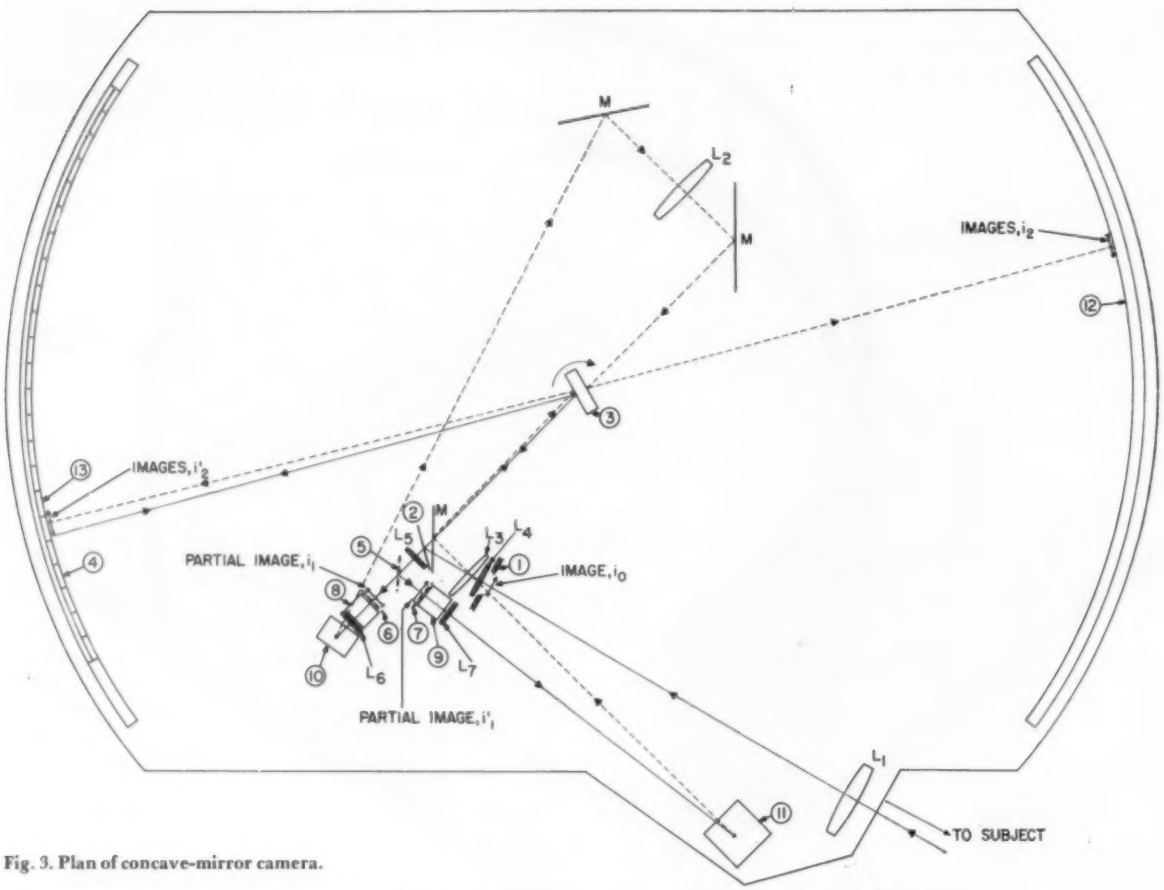


Fig. 3. Plan of concave-mirror camera.

(1) Framing window
(2) Front surface mirror
(3) Rotating mirror
(4) Concave mirrors
(5) Slotted mirror
(6), (7) Slit systems
(8), (9) Rhomboid prism units
(10), (11) Mirrors (paired)
(12), (13) Film drums
M — Front surface mirror
L_1, L_2, L_3 — Image forming lenses
L_4, L_5, L_6, L_7 — Field lenses

Details of the Design

Figure 3 shows a layout of the camera. This drawing shows optical components in two central planes or "decks," similar to the pictorial drawing of Fig. 1. The ray paths shown by solid lines are in the upper sequencer deck; those shown by dashed lines are in the lower smear-camera deck.

One concave-mirror arc located at (4) is used to form images for two film drums. The image of the subject to be photographed is formed by L_1 at (1). The rays then pass via mirror (2) to the rotating mirror (3). Reflected from one of the 36 equally spaced concave mirrors, (4), the rays return to the rotor and are reflected to a slotted mirror (5). This mirror divides the beam into six equal vertical segments. Three alternate segments are transmitted to shutter slits (6) and the remaining three segments are reflected to shutter slits (7). The partial images, i_1 and i'_1 are brought to focus at the respective slit planes. Two similar slit systems, (6) and (7), are used. Each has three slits spaced $\frac{1}{3}$ frame apart. The two systems are set out of phase by $\frac{1}{6}$ frame. Rhomboid prisms located at (8) and (9) displace the apparent positions of the slits to form three rows of images on the film. The rays from (8) are dropped to the lower deck by two mirrors at (10) and relayed to the image-forming lens, L_2, where they then are reflected from the rotating mirror and form the final images i_2 on the film drum at (12). The rays from (9) are similarly dropped to the lower deck by mirrors (11), relayed to L_3 and form the final images i'_2 on the film at (13). Field lens L_4 is used to project lens L_1 into the concave mirrors. Field lenses L_5, L_6 and L_7 are chosen to project images of the concave mirrors to lenses L_2 and L_3 by way of any of the three slits in the respective paths. In this system all images are of equal dimensions.

A uniform brightness for all points in the filmed images is obtained by making the height of L_1, L_2 and L_3 equal to the heights of the concave mirrors and by making the width of these lenses twice the concave-mirror spacing. The latter dimension fixes the minimum effective width of the rotating mirror to be four-thirds the concave mirror spacing. (If a narrower rotating mirror is desired for reasons of increased framing speed, it is feasible to reduce this value to two-thirds the concave-mirror spacing. The edges of the images will then be exposed at half the intensity of their centerline.)

The specifications of the camera are given in Table I. The parallelepiped prism units each consists of four prisms with parallelogram apex angles of 45° and with sides at right angles to the parallelograms. The assembly

Table I. Specifications of Concave-Mirror Framing Camera.

(The camera will be housed in a unit approximately 50 by 40 by 10 in.)

Number of concave mirrors	36
Number of frames generated	216
Radius of curvature, concave mirrors, in.	36
Height, concave mirrors, in.	3
Width, concave mirrors, in.	15/16
Spacing, concave mirrors, in.	1.0
Radius, concave mirror circle, in.	24
Radius, film circles, in.	24
Film drum arcs, deg	~90
Film width, mm	70
Image heights, each frame, in.	0.75
Image width, each frame, in.	1.0
Rotating mirror width, in.	2.0
Rotating mirror height, in.	6.0
Rotating mirror speed, rps	600
Framing rate per track, per sec	~180,000
Framing rate, 6 tracks, per sec	$\sim 1.1 \times 10^6$
Framing time at 600 rps (6 tracks), sec	$\sim 9.3 \times 10^{-7}$
Exposure time (3.6 mil slits), sec	$\sim 2 \times 10^{-8}$
Exposure time (72 mil slits), sec	$\sim 4 \times 10^{-7}$
Effective aperture	$f/22$
Estimated resolution, line pairs/mm	20

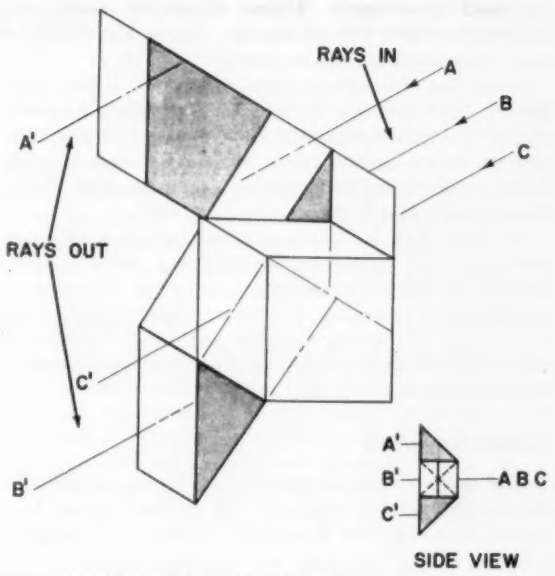


Fig. 4. 45°, 90° parallelepiped prism unit.

is shown in Fig. 4. Two of the prisms reflect the parallel rays A and B to paths A' and B' displaced up and down approximately one frame height without lateral displacement. The remaining two prisms are combined to displace ray C to the side and then back to C′, a continuation of C. The sidewise deflection is chosen to equalize the path length CC' to that of AA' and BB'. The slit units will be removable so that the operator can select any slit combination desired. The film drums will be made with vacuum film holders to position each film accurately.

The rotating mirror is mounted in "extra precision" ball bearings. The mirror will be belt driven from two universal wound motors rated $\frac{3}{4}$ hp at 8000 rpm. Speed will be controlled by a variable transformer. Overvoltage of twice the rated voltage will be used, if necessary, to attain the desired speed. Our experience with similar rotating mirrors indicates that speeds of 800 rps will be attained if wanted.

The rotor speed of 600 rps listed in Table I is a conservative value. The bursting speed of a good rotor is about ten times greater. In this type of camera the resolution in the image is greatly dependent on the planarity of the rotating mirror since the light beam is reflected off this mirror three times and the rotor is greatly separated from the images formed. Rotor speed therefore will be limited by distortion rather than by strength. The effect of elastic distortion on rotating mirrors has been discussed by Holland and Davis.[2] It appears that higher rotor speeds can be achieved, however, by using a beryllium mirror in the rotor and by compensating as far as possible the cylindrical distortion caused by the high rotor speed.

The use of a thick rotating mirror requires that the concave mirrors and the film drum be oriented to optimize the focal plane error and minimize velocity synchronization error. The analysis of the effect of thick mirrors on the focal distances and on image velocities has been carried out. The mathematical basis has been treated previously by Brixner[3] and by Bowen.[4] It has been determined that the velocity of the slit images on the film surface will remain constant to better than $\pm 0.2\%$ from one end of the film drum to the other. The images on the film are not quite stopped for all positions of the rotating mirror owing to the fact that the error in the velocity of the images in the slit plane is opposite in sign to the film writing error. A distortion in the widths of the images of $\pm 0.3\%$ will result. The velocity error is not great enough to contribute to loss of resolution in the final images.

Discussion

The design of this camera permits considerable flexibility in adapting the shutter system to the solution of special photographic problems. The system of six equally spaced slits of equal width may be considered to be the normal mode of operation. In this setup the camera is intended to be used as a means of acquiring x,y,t data with clearly defined time resolution. It appears that a motion picture for projection purposes can be regenerated on standard 16mm film by using the camera as part of a copying setup.

The two film tracks may also be handled as independent but synchronized cameras. One potentially useful method of using the films independently is to employ wide slits for one film and narrow slits for the second. It would be possible by this trick to obtain two records of the same event at two exposure levels. This could, for example, permit a low time-resolution color record on a relatively slow emulsion while simultaneously recording a high-resolution black-and-white record on a highly sensitive film. Where exposure level is in doubt, two records on the same type of film could be recorded at two exposure levels, thus improving the chance of obtaining a correctly exposed record of an event which may be too costly to repeat a second time.

Another improvisation would be the use of two slits for each image train. A double-slit system would record but a single image of all portions of the subject in which no changes have occurred while giving two images of those portions in which motion changes in particular

had developed. These changes would be much more easily detected in the contrast of a double image located in a background of a single image.

Since the focal-plane shutter system writes some portion of the frame at all times, it offers a greater chance for establishing the time of onset of a specific change in the subject. The time "distortion" in the frame could therefore be more of an advantage than a disadvantage in defining an event.

In conclusion, we restate that this camera is primarily intended as an instrument for obtaining precise data for analysis of rapid events which may be observed by photographic recording. It is an attempt to combine the advantages of framing cameras and smear cameras in one package while retaining much of the desirable features of each.

Acknowledgments

The authors wish to mention the assistance given by several people. We thank David Oakley of the University of California Lawrence Radiation Laboratory for the interest taken in the work and for several helpful discussions and suggestions which have aided us in achieving the present design. Rolf Goderstad of this Laboratory has been most helpful in the engineering of the design. Gipson Malone, Maurice Collins and John Derwin have all assisted in the development of components and in making preliminary bread-board layouts to confirm and improve on ideas incorporated in the final design. Herman Templin assisted us by his examination of the concave-mirror optics to determine the expected resolution of these mirrors.

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Résumé

Une caméra multi-images à miroir tournant avec obturateurs focaux multiples

S. J. Jacobs, J. D. McLanahan et P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

On a réalisé une caméra qui utilise plusieurs miroirs concaves en combinaison avec un miroir tournant unique pour créer une série reliée d'images qui passent devant plusieurs fentes faisant fonction d'obturateurs focaux. Les images vues par les fentes sont transmises de manière à former des rangées séparées d'images dans un système multiple de caméra maculeuse. En combinant 30 miroirs concaves avec 6 fentes correctement phasées, on peut enregistrer un total de 180 images en approximativement $\frac{1}{10}$ème de tour du miroir tournant.

La caméra actuellement en construction au Laboratoire d'Artillerie Navale des Etats-Unis utilisera deux faces réfléchissantes, mesurant 6 pouces sur 2, d'un miroir tournant de forme rectangulaire. A la vitesse prévue de 600 t/s pour l'élément tournant, on atteindra approximativement 10^6 images/s. Chaque image mesurera environ 0,8 pouce de haut et 1,0 pouce de large. Il sera possible de faire varier le rapport du temps d'obturation au temps de prise de vue approximativement de 0,5 à 0,05 en changeant la largeur des fentes utilisées dans la caméra. L'ouverture effective restera fixe à environ *f*/20. Ces travaux ont été patronés en partie par la Commission d'Energie Atomique avec la participation du Laboratoire de Radiation Lawrence de l'Université de Californie, Livermore, Californie.

Zusammenfassung

Eine Bildreihenkamera mit rotierendem Spiegel und Mehrfach-Schlitzverschlüssen

S. J. Jacobs, J. D. McLanahan und P. F. Donovan, U.S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

Es wurde eine Kamera entworfen, die eine Anzahl konkaver Spiegel sowie einen einzelnen rotierenden Spiegel hat, um eine verbundene Sequenz von Bildern zu schaffen, die an mehreren Schlitzen (die als Schlitzverschlüsse funeren) vorbeiziehen. Die durch die Schlitze gesehenen Bilder werden übertragen um in einer Mehrfach—"Schmier"—Kamera Anordnung getrennte Reihen von Aufnahmen zu ergeben. Durch eine Kombination von 30 Konkavspiegeln mit 6 entsprechend angeordneten Schlitzen können insgesamt 180 Bilder in ungefähr 1/10 Umdrehung eines rotierenden Spiegels aufgenommen werden.

Die jetzt beim Naval Ordnance Laboratory im Bau befindliche Kamera wird 2 verspiegelte 6 × 2 Zoll Flächen eines rechteckigen rotierenden Spiegels benützen. Bei der erwarteten Geschwindigkeit des Rotors von 600 Umdrehungen/s werden ungefähr 10^6 Bilder je Sekunde erzielt werden. Jedes Bild wird ungefähr 0,8 Zoll hoch und 1,0 Zoll breit sein. Durch Änderung der Breite der verwendeten Spalte wird es möglich sein, das Verhältnis zwischen Verschluss und Aufnahmezeit von rund 0,5 zu rund 0,05 zu ändern. Die wirksame Öffnung wird bei rund 1:20 fixiert bleiben. Diese Arbeit wurde teilweise durch die Atomic Energy Commission durch das University of California Lawrence Radiation Laboratory, Livermore, Kalifornien, ermöglicht.

Edit. Note: A layout model of the camera described was exhibited at the meeting.

Flash Light Source Measurement

By GEORGE H. LUNN

A method of measuring the light/time variations of flash light sources is described. A streak camera (after Brixner) has a neutral density step wedge over the slit. The light source to be recorded is arranged to illuminate the slit and step wedge uniformly at all points. Thus a number of light output/time records are produced simultaneously, the ratio of incident light to each record being known. Microdensitometer studies of these records are made from which logarithmic and linear graphs result. H & D curves of emulsion–developer combinations are also produced at submicrosecond exposures. The advantage of logarithmic display is discussed.

The flash light source to be measured is arranged, either by means of diffusing screens or condenser lenses, to illuminate uniformly a neutral density step wedge placed over the slit of a streak camera.

The number and density of the steps of the wedge depend on the required dynamic range. The following densities were found adequate, viz: 0.0, 0.5, 1.0, 1.5 and 2.0. The wedge was made by the deposition of rhodium on an optical flat under controlled conditions. The actual transmission of each step was measured after production and due allowance made for errors in manufacture.

Camera

The streak camera was constructed after the manner of Brixner[1] as this design allows the use of photographic plates or films, other designs having curved film planes. The camera details are shown in Fig. 1. The mirror was driven by a directly coupled electric motor (two-phase induction-type) and was capable of operation from 10 cps (cycles per second) to 1000 cps. The maximum writing speed on the recording medium with this system was about 6 mm/μsec. The usual writing speed used in these experiments was 3 mm/μsec with a possible time resolution of 10^{-8} sec (10 mμsec), and a usable record duration of at least 30 μsec. The mirror unit can readily be changed to an air-driven type to give writing speeds up to 40 mm/μsec if required. Synchronization of the event to the camera was achieved by reflecting a light beam from the back of the rotating mirror, to a photomultiplier system suitably placed to give an appropriate synchronizing signal.

Presented on October 17, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by George H. Lunn, Atomic Weapons Research Establishment, United Kingdom Atomic Energy Authority, Aldermaston, Berks., England.

Densitometer

A typical record is shown in Fig. 2. The light source was an Arditron flash tube with a discharge capacitor of $\frac{1}{2}$ μf, operating at 10 kv. The record was taken on Ilford HPS plate, developed in Ilford Microphen for $6\frac{1}{2}$ min at 68 F with continuous agitation.

Each complete record consists of five image density/time streak records, the ratios of incident-light being known.

The image densities are measured on a recording microdensitometer. The photomultiplier output can be recorded directly on a strip chart recorder giving a linear light transmission plot. An improved system was based on a circuit by Bradford.[2] The photomultiplier output current is held constant by varying its applied potential and thus its multiplication factor. The applied potential is then sampled and recorded. Over the desired range, this signal is found to vary directly with image density. The instrument was calibrated by taking a record of a known neutral density step wedge.

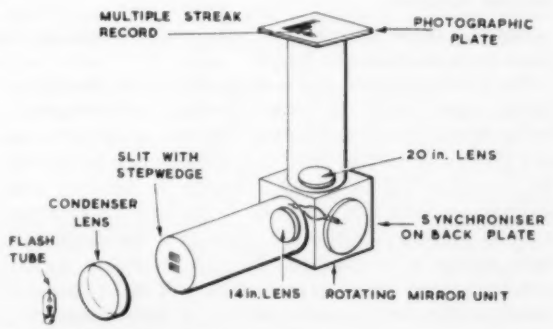


Fig. 1. Diagram of camera.



Fig. 2. Typical record.

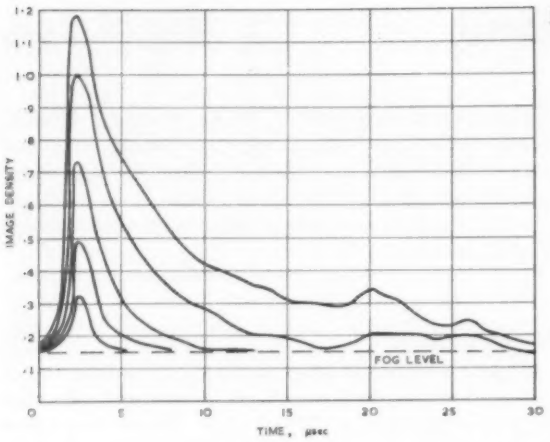


Fig. 3. (Left) Image Density — Time.

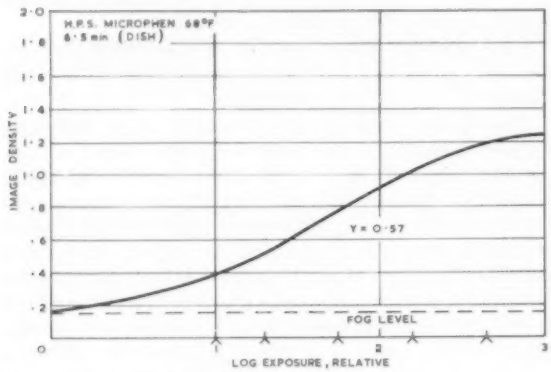


Fig. 4. Image Density — Log Exposure.

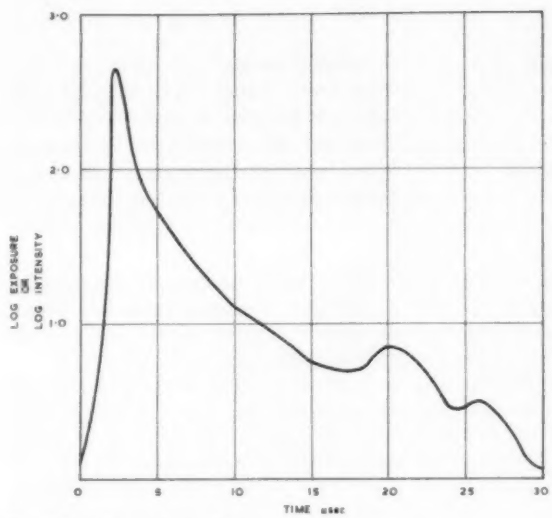


Fig. 5. Log Intensity — Time.

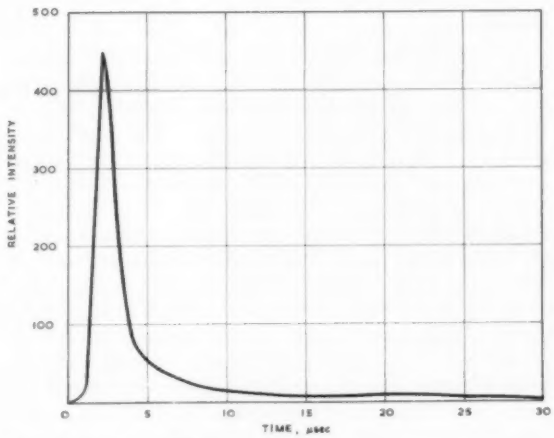


Fig. 6. Intensity — Time.

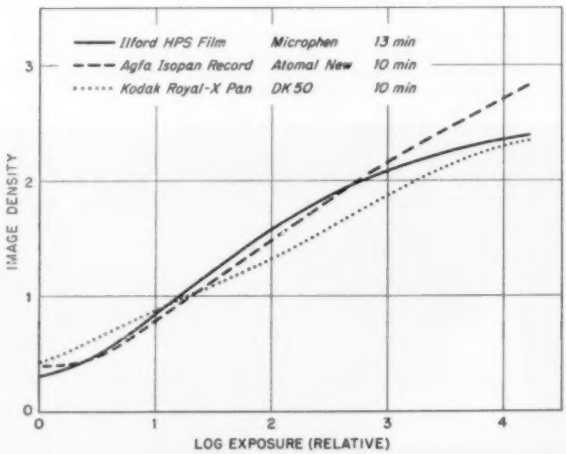


Fig. 7. Image Density — Log Exposure (for three other emulsion-developer combinations); exposure $\sim 10^{-7}$ sec; developer temperature 68F.

Record Analysis

Figure 3 shows the group of image density-time curves taken from the record in Fig. 2.

The camera step wedge was found to have the following densities: 0.0, 0.45, 0.90, 1.35 and 1.60 per section. Using these figures and taking the five image densities at a given time instant from Fig. 3, Fig. 4 can be plotted. To complete Fig. 4, image densities at different time instants are used and arranged to fit. The log exposure scale is arbitrary until such time as a standard flash light source is established. Then a record of such a standard under identical conditions will make this scale absolute. As the exposure time in a streak camera is constant for all parts of the emulsion log exposure is directly proportional to log intensity of the light received at the slit.

Figure 4 shows image density plotted against log exposure, which is the same as the characteristic emulsion – developer or H & D curve, with one additional quality – these characteristic curves are at submicrosecond exposures, and are directly applicable in high-speed recording.*

Using Fig. 4 to interpret and replot the upper curve of Fig. 3 gives Fig. 5. This shows log intensity of the flash source on a relative scale against time.

Previously, such light-time curves were obtained from oscillographic recordings of photomultiplier outputs, giving light intensity on a linear scale. Figure 6 is a

* Similar characteristic curves for other emulsion – developer combinations have more recently been obtained (October 1960), and are shown in Fig. 7.

replot of Fig. 5 showing intensity on such a linear scale, and is found to be identical with previous records within experimental error.

Conclusions

Comparison of Figs. 5 and 6 clearly shows that Fig. 5 gives more information. Figure 6 was readily produced from Fig. 5, but the reverse process is quite impracticable.

As the photographic process is basically of a logarithmic nature, and as flash light sources are mostly used as photographic aids, then the logarithmic presentation is more logical. The technique described produces such curves and also gives characteristic emulsion-developer curves at relevant exposure times.

At a later date, intensity/time curves of various light sources on the same relative scales and various emulsion–developer curves will be available.

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Résumé

Le mesurage des sources de lumière-éclair

GEORGE H. LUNN, A. W. R. E.,
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L'auteur décrit un procédé pour mesurer les variations lumière-temps des sources de lumière-éclair. Une caméra à stries (d'après Brixner) est munie d'une clavette à crans de densité neutre au-dessus de la fente, et la source de lumière à enregistrer est disposée de manière à éclairer la fente et la clavette à crans d'une manière uniforme en tous points. On obtient ainsi simultanément plusieurs enregistrements du débit lumineux en fonction du temps, le rapport entre la lumière incidente et chaque enregistrement étant connu. On fait des études au microdensitomètre de ces enregistrements, d'où l'on dérive des graphiques logarithmiques et linéaires. On détermine aussi des courbes H et D de combinaisons émulsions/révélateurs pour des temps d'exposition de l'ordre des submicrosecondes. L'auteur examine les avantages des présentations logarithmiques.

Zusammenfassung

Das Messen von Blitz-Lichtquellen

GEORGE H. LUNN, A. W. R. E.,
Aldermaston, Berks, England

Der Autor beschreibt eine Methode zum Messen von Licht- und Zeitvariationen in Blitzlichtern. Eine Schlierenkamera (nach Brixner) trägt einen Stufenkeil über dem Schlitz und die zu messende Lichtquelle ist so eingestellt, dass sie den Schlitz und den Stufenkeil, der von neutraler Dichte ist, an allen Punkten gleichmässig beleuchtet. Auf diese Weise werden gleichzeitig eine ganze Anzahl von Aufzeichnungen über Lichtausbeute/Zeit gemacht, wobei das Verhältnis des einfallenden Lichts zu jeder Aufzeichnung bekannt ist. Es werden dann Mikrodensitometer-Studien dieser Aufzeichnungen vorgenommen, aus denen sich logarithmische und lineare D/agramme ergeben. Auch H und D Kurven verschiedener Emulsions-Entwickler Kombinationen werden bei Belichtungszeiten von unter einer Mikrosekunde angefertigt. Der Vorteil logarithmischer Darstellung wird behandelt.

Two High-Speed Color Films and a Reversal Print Film for Motion-Picture Use

By N. H. GROET, T. J. MURRAY and C. E. OSBORNE

Eastman (or Kodak) Ektachrome ER Daylight and Type B Films are high-speed color reversal camera films designed for 35mm and 16mm motion-picture photography. Ektachrome Reversal Print Film, designed for the same process as the camera films, may be used for making high-quality prints from camera originals. Film structure, sensitometric characteristics, exposure requirements, suggested filters, and printing behavior of the new films are discussed.

THE PRACTICE of motion-picture photography in color has experienced a succession of many new and improved color films. The manufacturers of photographic materials, recognizing that improved films would reflect both a reduction in production costs and improved quality to the producer, have incorporated the results of research and technological progress in these new color films. In view of the cost of stage lighting and the degree of magnification employed in modern projection systems, particular emphasis has been placed on the development of higher-speed and finer-grained motion-picture color films.

Typical of these photographic materials are Ektachrome Commercial Film, Type 7255, described by Groet, Liberman and Richey to the Society in April, 1958,[1] and Eastman Color Negative Film, Type 5250, described by Dundon and Zwick to the Society in May, 1959.[2] These color films were designed to have the maximum speed commensurate with the medium- to fine-grain characteristics required for excellent picture quality. However, these films, with rated exposure indices of 25 and 50, respectively, are frequently too low in speed for sport, available-light, high-speed and data-recording types of photography.

Recent improvements in photographic emulsions, sensitization, and dye-forming materials now make it possible to manufacture color reversal films with markedly higher film speed without the large losses in quality formerly attendant upon such attempts. As a result of these technological gains and in consideration of speed requirements placed on films used under conditions when inadequate lighting is a problem, two new, high-speed, reversal color films are being manufactured for motion-picture use. These films are Eastman (or Kodak) Ektachrome ER Film, Types 5257 (35mm) and 7257 (16mm) for use with daylight illumination, and Eastman (or Kodak) Ektachrome ER Film, Types 5258 (35mm) and 7258 (16mm) for use with tungsten illumination. The purpose of Part I of this paper is to discuss the characteristics and usage of these films.

Several methods for making color prints from reversal camera originals are discussed in the literature. In many cases these systems require different chemicals and modified equipment for processing the print film as compared to the processing requirements of the camera original. As a result, various operations, such as processing the original camera film, printing the camera film and processing the color prints, are frequently carried out in different laboratories.

Many operations involve security regulations or time considerations, and a print film is required which can be processed in the same chemicals and equipment used for processing the camera film. Hence, a new print film which fulfills these requirements is being introduced, along with the two new

Communication No. 2120 from the Kodak Research Laboratories, presented on May 4, 1960, at the Society's Convention in Los Angeles by Daan Zwick for the authors all of whom are at the Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on September 29, 1960.)

camera films. This film is Ektachrome Reversal Print Film, Type 5386 (35mm) and Type 7386 (16mm). It is the purpose of Part II of this paper to discuss the characteristics and usage of the new reversal print film.

PART I. CAMERA FILMS

Ektachrome FR Film, Type 5257 (35mm) and Type 7257 (16mm), is a high-speed, moderate-grain, camera film designed for use under daylight conditions. It is especially intended for situations in which the illumination level is low or for high-speed photography when sufficient exposure cannot be obtained with slower-speed color reversal films.

For daylight illumination, the exposure index of this film is 160. With a shutter speed of approximately $\frac{1}{50}$ sec (24 frames/sec), the basic exposure is 14 ft-c at $f/1.4$. In terms of high-speed photography under average sunlight conditions, an aperture of $f/4.0$ would be required for a rate of 1000 frames/sec. Except in an emergency, it is not desirable to use this film with tungsten light sources because of the color correction required and the attendant sacrifice in film speed. However, the daylight-balanced Type 5257 may be preferable in many existing light situations where fluorescent or fluorescent plus daylight lighting exists. Suggested filters for exposing the daylight film are shown in Table I.

Ektachrome ER Film, Type 5258 (35mm) and Type 7258 (16mm), is a high-speed camera material intended for use under difficult tungsten lighting conditions where sufficient exposure cannot be obtained with slower-speed color reversal films. It can be used in a number of applications, including the filming of industrial pictures under existing plant illumination, photography of various nighttime sporting events, high-speed photography, and color-newsreel work.

For tungsten illumination, the exposure index of the film is 125 and is equivalent to 18 ft-c at $f/1.4$ for $\frac{1}{50}$ sec. For daylight illumination with a Kodak Wratten Filter No. 85B over the lens, the exposure index is 80. Suggested filters for exposing the tungsten film are shown in Table II.

For most subject matter, where even higher film speeds are required, the effective speed of both films can be doubled by increasing the time of development in the first developer. The increase in speed is accompanied by a slight loss in both maximum density and latitude. A slight increase in graininess also results from the modified processing.

General Description

Both Ektachrome ER Films are multilayer three-color reversal films with incorporated dye-forming couplers. The structure of the films is shown schematically in Fig. 1. The three color records are provided by emulsion layers sensitized to blue, green and red light, respectively, coated on a safety film support. A clear gelatin overcoat is provided against abrasion. A yellow-filter layer between the blue- and green-sensitive layers prevents blue light from reaching the bottom two emulsion layers and a clear gelatin interlayer is provided for the prevention of color contamination between the green- and red-sensitive layers. The antihalation layer, which is coated directly on the support, is separated from the red-sensitive layer by a clear gelatin interlayer. The emulsion layers, in addition to the silver halide, contain coupler dispersions from which a yellow dye is produced, during processing, in the blue-sensitive layer, a magenta dye in the green-sensitive layer and a cyan dye in the red-sensitive layer. The proper choice of developing agent and of the three color-forming couplers results in dye absorption curves shown in Fig. 2, where density is plotted against wavelength. The low unwanted absorptions of the dyes in the new films contribute to the good color quality obtained with these films.

The characteristic curves for the reproduction of a scale of neutrals, obtained by exposing each film to its own illuminant, are shown in Fig. 3. The curves are plotted in equivalent neutral density and approximate the appearance

Table I. Filters Required With Various Light Sources for Exposure of Ektachrome ER Film, Type 5257.

Light source	Camera filter	Exposure index
Daylight (sunlight plus some skylight)	None	160
3200 K Tungsten Lamps	Kodak Wratten Filter No. 78A plus Kodak Light Balancing Filter No. 82A	20
"CP" lamps (approximately 3350 K) or or Photofloods	Kodak Wratten Filter No. 78A	32

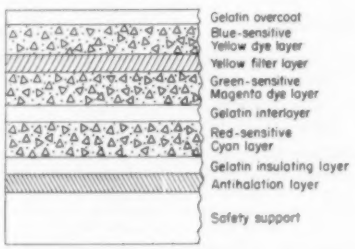


Fig. 1. Schematic cross-section of Ektachrome ER Film, Types 5257 and 5258.

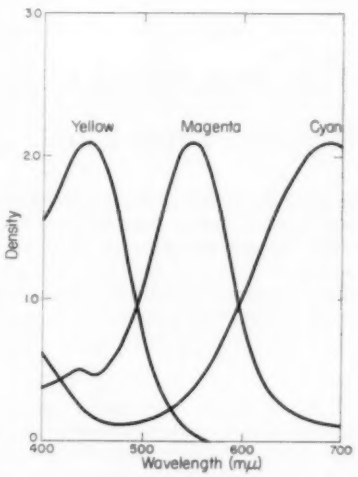


Fig. 2. Spectrophotometric curves of three dyes in Ektachrome ER Films.

Table II. Filters Required With Various Light Sources for Exposure of Ektachrome ER Film, Type 5258.

Light source	Light source filter	Camera filter	Exposure index
3200 K Tungsten Lamps	None	None	125
Photoflood Lamps	None	Kodak Wratten No. 81A	100
3350 K Tungsten Lamps	None	Kodak Wratten No. 81A	100
(Carbon arcs) M-R Type 170 150-Amp. H.I. arc	Straw-colored gel filter such as Brigham Y-1 over source	Kodak Wratten No. 85B	80
M-R Type 40 40-Amp. Duarc	Florentine Glass Filter over source	Kodak Wratten No. 85B	80
Daylight (mixture of sunlight and skylight)	None	Kodak Wratten No. 85B	80

of this sensitometric exposure to the eye as well as the printing density of the processed camera film to currently available color print films.

Both films show little reciprocity failure for exposures made at high intensity and extremely short times; therefore, it is unnecessary to use compensating filters for high-speed photography.

With these characteristics, both Type 7257 and 7258 originals are suitable for direct projection, or, where needed, color prints can be made by several currently available methods. For example, prints may be made from the originals by printing onto Eastman Reversal Color Print Film, Type 5269, or prints may be made by a release printing system described before this Society by Zwick, Bello and Osborne in April, 1956.[3] This latter system employs the use of a color internegative on Eastman Color Internegative Film,

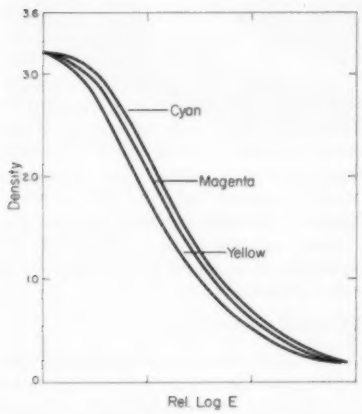


Fig. 3. Characteristic curves for Ektachrome ER Films, Types 5257 and 5258.

Type 7270, which is in turn, printed onto a positive color film such as Eastman Color Print Film, Type 7383. A third method for making release prints on a new print film will be discussed in Part II of this paper.

The new camera films differ from Ektachrome Commercial Film in that the high-speed emulsions cause some loss in quality owing to increased graininess and a loss in picture definition. The high-speed Ektachrome films are not suggested as replacements for such quality films as Ektachrome Commercial Film, but are designed to supplement the use of these high-quality films in situations where unfavorable lighting conditions are encountered.

Processing

Detailed information on processing and manuals covering specific steps and equipment are available from the Motion Picture Film Dept. of Eastman Kodak Co. A license to process these films is available at a moderate charge; information relative to the license may be obtained from Eastman Kodak Co. In general, it can be stated that these films require specific formula changes in the first and color developers and time and temperature adjustments from the Ektachrome Commercial Film process. However, the new films can be processed in the equipment which was designed for processing the Ektachrome Commercial Film.

PART II. The Print Film

General Description

Ektachrome Reversal Print Film, Type 5386 (35mm) and Type 7386 (16mm), is a fine-grain, high-definition film intended for making quality prints from reversal camera originals. The new film is especially designed for processing in the same solutions and equipment as are employed for the high-speed camera films described in Part I. Since the Ektachrome ER Films and the Ektachrome Reversal Print Film are compatible from a processing viewpoint, this combination of camera and print film satisfies the needs of those users requiring security precautions or where the elapsed time between original photography and the production of a color print must be held to a minimum.

The structure of the print film is similar to that of the camera film with two important exceptions: The emulsions used are finer-grained and absorbing dyes are distributed throughout the film for the purpose of preventing scattered light from traveling significant distances in the emulsion layers. As a result, the film is very fine in grain and high in definition; prints made on this film compare favorably with the original in these respects. The contrast of the print film is lower than that of the camera film; lower contrast is required in order that the tonal qualities of the original may be preserved.

Printing

The use of Ektachrome Reversal Color Print Film, Type 7386, is not restricted to making color prints from Ektachrome ER originals; as in the case of Eastman Reversal Color Print Film, Type 5269, the new print film may be used for making release prints from any color reversal original. In the case of release prints from Ektachrome ER Films, the new film does have the advantage that the print film may be processed in the same process as that required for the original camera film. Detailed instructions for printing will be supplied by the Motion Picture Film Dept. of Eastman Kodak Co. For the purpose of this paper, it is sufficient to state that the speed and contrast of the new film are similar to those of Eastman Reversal Color Print Film, Type 5269, and that the same printing equipment may be used for both films.

Intercut Originals

An important point should be mentioned here. Release prints from Ektachrome ER Films will appear somewhat higher in contrast than prints from Ektachrome Commercial Film, Type 7255. The difference in contrast results from the fact that Ektachrome ER films are designed for direct projection and are higher in contrast than Ektachrome Commercial Film, which is designed to have lower contrast and is better suited for printing onto a reversal print film.

Therefore, in a production requiring the use of the two camera films, the slower reversal film for scenes having adequate illumination and the high-speed film for "hard-to-get" scenes, it is advisable to intercut only at obvious scene changes.

Processing

As in the case of the Ektachrome ER Films, information on processing and manuals covering detailed characteristics of the process steps and equipment are available from the Motion Picture Film Dept. of Eastman Kodak Co. The Motion Picture Film Dept. can also supply information about a license to process the film; the license is available at a moderate charge. Instructions for printing a soundtrack on the print film will also be available.

At the Convention, a demonstration reel was projected to show various applications of the Ektachrome ER Films and the quality of color prints made onto the Ektachrome Reversal Print Film.

References

1. N. H. Groet, M. Liberman and F. Richey, "An improved professional 16mm reversal camera film," *Jour. SMPTE, 68:* 8–10, Jan. 1959.
2. M. L. Dundon and D. M. Zwick, "A high-speed color negative film," *Jour. SMPTE, 68:* 735–738, Nov. 1959.
3. D. M. Zwick, H. J. Bello and C. E. Osborne, "A 16mm color internegative film for use in color motion-picture photography," *Jour. SMPTE, 65:* 426–428, Aug. 1956.

Narrow-Bandwidth Video-Tape Recorder Used in the Tiros Satellite

By JOSEPH A. ZENEL

A magnetic tape recorder intended for use as a video recorder, that is, a storage device for television-originated images, has been developed. Extremely smooth tape motion has been obtained within the limited volume and weight permitted a recorder intended for a satellite. This novel design also satisfies the requirement of very low power consumption. Electrical performance and physical characteristics are presented in detail.

UNLESS direct communication is possible at all times with a satellite whose primary mission is to make scientific observations from a vantage point in space, some means of information storage in the vehicle must be provided. If the information to be stored consists of video signals corresponding to "visual" images observed by the satellite, a recorder that can reproduce the original time base accurately as well as the signal bandwidth is required. Such a recorder was developed and used in the successful Tiros I satellite, and the problems involved in developing this recorder are discussed herein.

The entire Tiros satellite system was developed and built by Radio Corp. of America's Astro-Electronic Products Division for the National Aeronautics and Space Administration under the technical direction of the U.S. Army Signal Research and Development Laboratories.

General Requirements of the Recorder

At first consideration, the task of building a video recorder for space vehicle use appears to be a formidable one. However, when it is realized that what is needed is a recorder to store a series of "snapshots" produced by a television camera working to standards which are dictated only by the desired objectives, the task reduces to one of more tractable proportions. The recorder described here was developed to store a nominal 500 by 500-element television image, scanned in 2 sec, on a single-image basis. This means the recorder has to handle a bandwidth of 0–62.5 kc with a tape-speed stability such that the individual images will be comprehensible to the eye. A tape speed of 50 inches per second was chosen so that the smallest recorded wave-length would be held to a conservative figure. An FM carrier frequency of 85 kc was used, with the black signal occurring at 100 kc and the white signal at 70 kc. Hence, the highest frequency that has to be accommodated (the highest first-order sideband, 150 kc) results in a resolution of 3000 cycles/in.

Obtaining the tape-speed stability required was the difficult part of the task, and therefore this article is limited to a discussion of the transport.

Although modern high-quality instrumentation recorders are capable of providing the tape-motion stability necessary, the basic problem in designing a transport for use in a space vehicle is that of duplicating such performance with a mechanism which is several orders of magnitude reduced in size, weight, volume and power consumption. In addition, such a transport must be able to withstand the stresses of launching and the rigors of the space environment in which it will be expected to operate; and it must be reliable enough to operate unattended throughout its expected life.

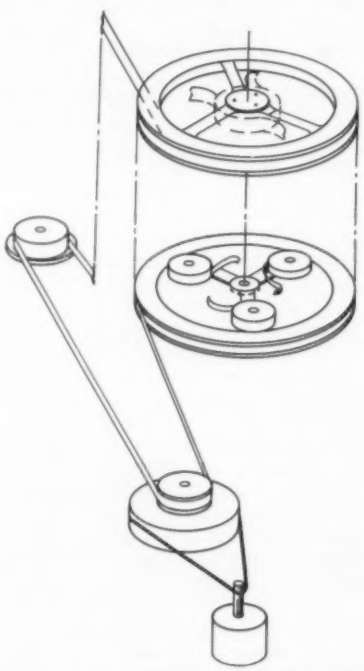


Fig. 1. The essential parts of the tape-transport mechanism.

Presented on May 3, 1960, at the Society's Convention in Los Angeles by Joseph A. Zenel, Astro-Electronics Products Div., Radio Corp. of America, Princeton, N. J.
(This paper was received on July 20, 1960.)

The Transport Mechanism

The transport was developed to meet these requirements. A sketch of the mechanism, which is of unusual design, is shown in Fig. 1. The basic tape-handling mechanism consists of a capstan, an idler and two coaxial reels mounted in a triangular configuration. The reels are coupled to each other by means of an assembly of constant-tension springs, and the idler and capstan are angled in such a way as to aid the tape in moving from the plane of one reel to that of the other. The drive mechanism consists of a 400-cycle synchronous-hysteresis motor whose shaft is coupled to the capstan by means of an endless polyester film belt. Operation of the transport is as follows: the motor drives the capstan, the capstan pulls the tape and the tape pulls the supply reel. The take-up reel is then pulled by the supply reel because the two reels are coupled to each other. Both reels, of course, do not move in perfect unison; there is relative motion between them. The constant-tension springs permit this relative motion while still maintaining constant tension on the tape. The complete transport as it would be mounted in a space vehicle is shown in Fig. 2.

Electrical Performance

The time base of the original video signal must be reproduced accurately. Any error in the time base will show up as both a position error of the individual picture elements and as an amplitude error, which will make a noise contribution to the signal. The standard flutter measurement used in audio work offers a clue to how good or bad the position error will be in a video recorder, but the relationship is rather complex and beyond the scope of this article. Suffice it to say that the flutter of the transport developed (0.03% rms, for the range of 0.5–250 cps) accounts for less than the limit of displacement error of one part in 500 required for the presentation of a television image of a like number of elements. The effect of flutter at higher frequencies is of small enough magnitude to be masked in system noise. Overall speed drift is ±0.5%, which is negligible in the system.

A television-like image is shown in Figs. 3a and 3b. Figure 3a represents an image of 30 vertical lines, presented on the face of an oscilloscope, using the television standards already mentioned, with the displacement error set to zero at the left side of the image by the use of driven synchronization. Figure 3b rep-



Fig. 2. The tape transport, as mounted in the space vehicle.

resents only the right edge of an image consisting of 250 white vertical lines, or a 500-element television image. This portion of the image is presented this way so that the time-base error may more readily be seen. Just as in Fig. 3a, the displacement error has been set to zero at the beginning of each horizontal scan. Although the final system uses flywheel rather than driven synchronization, there is no discernible difference in the end result.

Design Features

The most important feature of this design is the spring coupling between the reels. This assembly makes possible the low power consumption (12 w, a-c) because very little power is used to develop tape tension; the virtually perfect constancy of tension on the tape makes a major contribution to tape-motion stability. The inherent reliability of such a simple tensioning mechanism as the constant-tension spring assembly accounts to a large degree for the reliability of the entire transport. The spring assembly for providing tension does, however, have one distinct disadvantage. The transport must, of necessity, be large compared to the volume of tape it carries, because of the large-diameter reels that are required. The reels must be of large diameter so that the differential radius, that is, the difference in radius between an empty reel and a fully loaded reel, will be small compared to the mean radius. Figure 4 shows the relationship between reel diameter, spring turns and tape length.

The differential radius must be small for three separate and distinct reasons. First, it determines the number of relative turns of the two reels; this number must be kept small so that the constant-tension spring capacity required will be kept within practical bounds. Secondly, the spring capacity, which depends directly on the differential radius, determines the range of load variation that the spring assembly reflects back into the driving motor. Thirdly, because the transport must operate in both directions, the belt theorem regarding belting over pulleys in nonparallel planes is satisfied only when both reels are equally loaded. Hence, the differential radius must be kept small enough for the proper tape tracking to be maintained with only a slight crown on the capstan and idler. Incidentally, no other tape guiding is used.

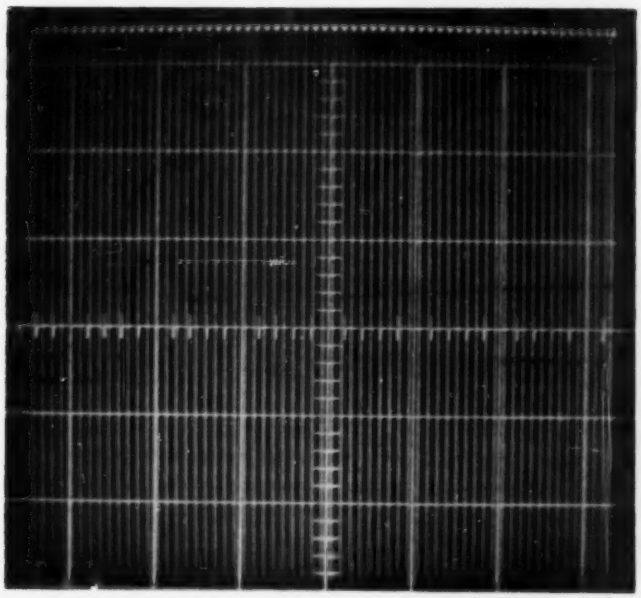


Fig. 3a. A 30-vertical-line TV image, reproduced from the magnetic recorder.

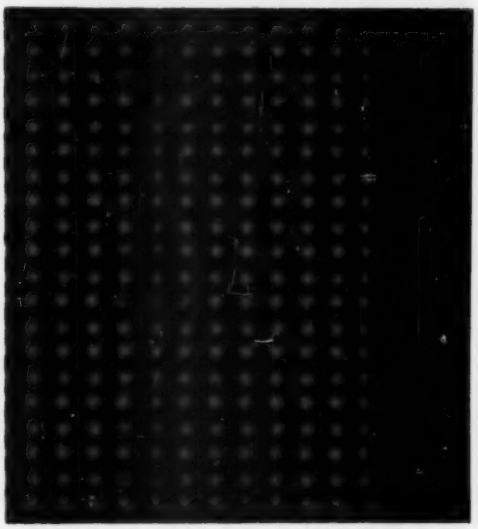


Fig. 3b. Right edge of 500-element TV image, reproduced from the magnetic recorder.

The most smoothly rotating member of any tape transport is usually the member with the highest stored kinetic energy. In this case, it is the rotor of the synchronous-hysteresis motor, which is rotating at 12,000 rpm. Consequently, it is this motion which should dominate the actual movement of the tape. Therefore a tight coupling between the motor and capstan is desirable. An endless polyester film belt, 0.001 in. thick, provides a low-compliance, high-traction coupling. This belt introduces no motion errors of its own as far as can be determined.

Bearing friction of all rotating members is kept low by the use of ball bearings exclusively. Each bearing is preloaded to remove all residual play. Bearings are lubricated with a silicone grease.

Satisfaction of Environmental Requirements

The transport is built to withstand the severe vibration and shock encountered in launching. Although designing for immunity to damage from vibration and shock appears to be a hardship, it is not without some reward. If a mechanical device is designed to withstand these stresses, it is almost impossible for some weak or troublesome component not to reveal its nature during environmental tests. In other words, inherently unreliable pieces are weeded out.

The transport is capable of operating over a temperature range of 0–50C for extended periods. There is no component part that shows sensitivity to temperature, at least within the range for which the transport was designed.

Although the transport was installed in a pressurized container inside the Tiros satellite, it is known that the transport is capable of operating for some time in a laboratory-produced vacuum.

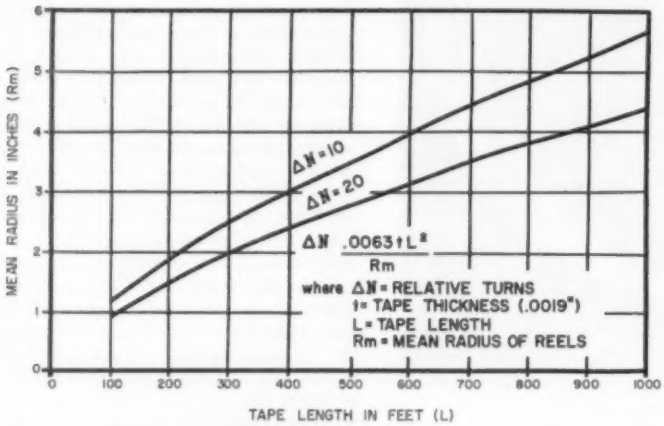


Fig. 4. Relationship between reel diameter, relative turns and tape length (based on work of S. P. Clurman).

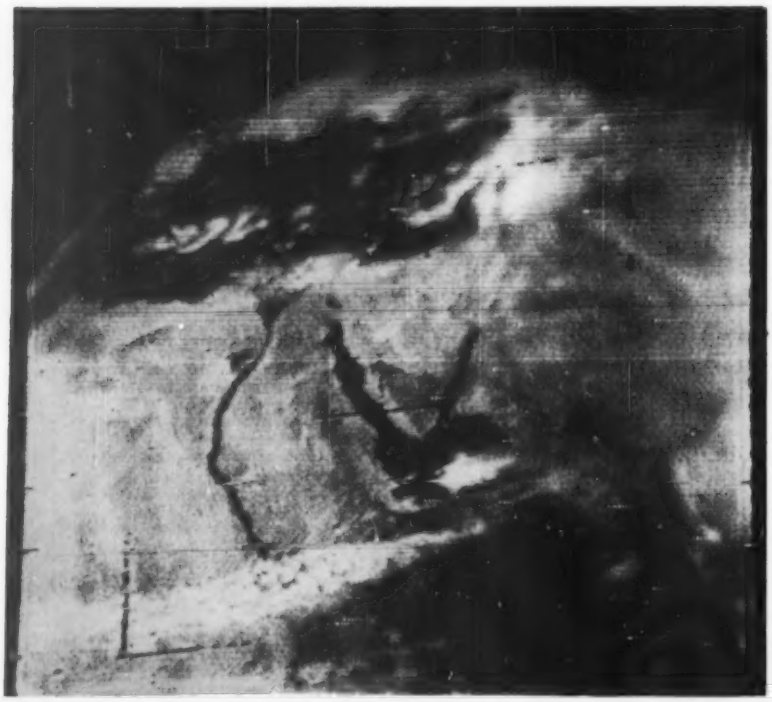


Fig. 5. Photograph of Earth, taken, stored on magnetic tape and reproduced by the Tiros I satellite. Red Sea, Suez Canal; Nile River at left; Mediterranean Sea in background.

Conclusions

From the experience gained in working with the transport in many months of overall system tests, the tape-transport mechanism appeared to be a very reliable device. Its subsequent use in the successful Tiros I satellite proved the soundness of its design and of the tests used to evaluate it. A photograph of the earth, developed from video signals which had undergone magnetic storage in the satellite, is shown in Fig. 5.

The most important specifications of the tape transport are as follows:

Power consumption, 12 w, a-c
Weight, 6 lb
Size, 12-in. diameter, 4 in. high
Speed drift, ±0.5%
Wow and flutter, 0.5–250 cps. 0.03% rms

Acknowledgments

The design of this transport was based on an idea originally suggested by Walter Eriksen and Joseph J. Ford, and was brought to fruition by Stanley P. Clurman and Vincent H. Liptak, all of the Radio Corp. of America.

The technique of making an endless polyester film belt was devised by Jack Kwik of the Signal Corps at Fort Monmouth, N. J.

standards and recommended practices

Proposed Revisions of American Standards

Published here for their three-month trial period are three proposed revisions of existing American Standards and one Proposed American Standard.

The proposed revision of American Standard 35mm Sound Motion-Picture Film, Usage in Camera, PH22.2-1954, includes a change in title which restricts the standard to photographic motion-picture film. A scope has been added which defines what the standard is intended to specify. The section pertaining to the relationship between photographic sound and picture has been rewritten to exclude the specific 20 ± ½ frame displacement. The engineering committee agreed that this specification is dependent upon camera design and varies widely among camera models. While there is no standard for picture-sound separation for a single system camera, the proper sync for projection purposes is accomplished during the printing process which is specified in American Standard Photographic Sound Record on 35mm Prints, PH22.40-1957.

The proposed revision of American Standard 16-Tooth 35mm Motion-Picture Projector Sprockets, PH22.35-1957, differs from the existing standard in that the dimensions of the idler sprocket are included and Dimension B is specified for all sprockets with the exception of the intermittent which varies in commercial practice from 0.943 to 0.953 in. Dimension t, which is dependent upon Dimension B, is not specified. However, industry practice has been to make this dimension smaller than Dimension B by 0.005 in.

The proposed revision of American Standard Dimensions for 200-Mil Magnetic Sound Records on 35mm and 17½mm Motion-Picture Film, PH22.86-1953, is dimensioned in accordance with American Standard Four Magnetic Sound Records on 35mm Film, PH22.108-1958. A section 2 has been incorporated in the revision which is intended to clarify magnetic recording head dimensions versus magnetic sound record dimensions. A new diagram has been provided and several editorial changes have been incorporated in the body of the standard in order to bring it into conformance with present-day practices.

Proposed American Standard

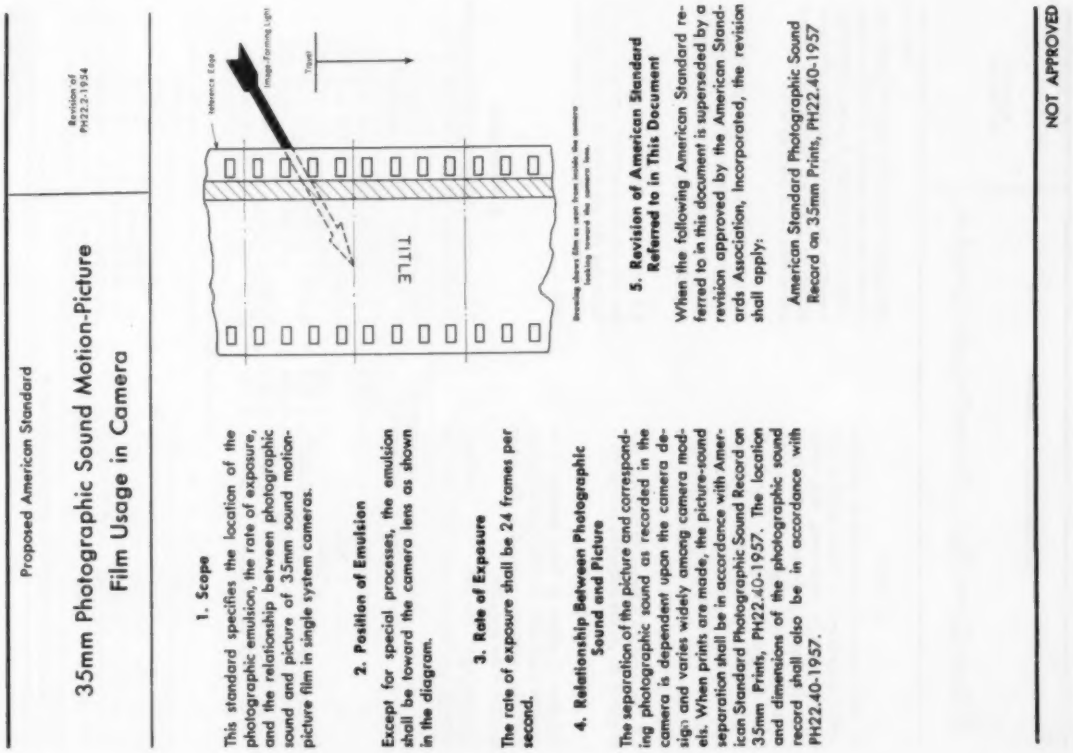
Proposed American Standard 16mm Multi-Azimuth Test Film, Magnetic Type, PH22.126, was initiated by the SMPTE Sound Committee. At their October 1957 meeting, the committee recognized the need for a film which could be used for determining the azimuth adjustment of a magnetic reproduce head without disturbing its adjustment. Accordingly, a special ad hoc committee was constituted to draft a proposed standard. Three separate drafts of the Proposed American Standard were considered by SMPTE technical committees prior to this published proposal.

If no adverse comments are received prior to February 15, 1961, the proposed revisions as well as the Proposed American Standard will be submitted to ASA Sectional Committee PH22 as the next step in securing the formal approval of the American Standards Association. All comments should be addressed to SMPTE Headquarters in care of the staff engineer.—*J. Howard Schumacher, Staff Engineer*

ERRATUM

Proposed American Standard PH22.51

Transpose: the drawings for Figs. 1 and 3, *Jour. SMPTE, 69:* 358, May 1960.



Proposed American Standard

16-Tooth 35mm Motion-Picture Projector Sprockets

Revision of PH22.35-1957

1. Scope

1.1 This standard is applicable to sprockets used in conjunction with 35mm motion-picture film perforated in accordance with either American Standard Dimensions for 35mm Motion-Picture Film, Alternate Standards for Either Positive or Negative Raw Stock, PH22.1-1953; American Standard Dimensions for 35mm Motion-Picture Positive Raw Stock, PH22.36-1954; or American Standard Dimensions for 35mm Motion-Picture Film, CS-1870, PH22.102-1956.

1.2 This standard is limited to sprockets employed in the picture projection mechanism.

2. Definitions

2.1 *Feed Sprocket.* A feed sprocket is a sprocket which pulls the film against tension. The name originally applied to the upper sprocket in the projector.

2.2 *Hold-Back Sprocket.* A hold-back sprocket is a sprocket which holds back the film against tension. The name originally applied to the lower sprockets in the film take-up section of the projector. In many present-day projectors the sprocket occupying this lower position no longer has the hold-back function and is, instead, an idler sprocket.

2.3 *Idler Sprocket.* An idler sprocket is a sprocket which neither pulls nor holds back film against tension. It is normally used to maintain a film loop.

2.4 *Intermittent Sprocket.* An intermittent sprocket is a feed sprocket employed to advance the film one frame at a time past the picture aperture at the designated frame rate.

3. Dimensions

3.1 The sprocket dimensions shall be as given in the diagram and table on page 1.

	Feed Sprocket	Intermittent Sprocket	Hold-Back Sprocket	Idler Sprocket
A	1.125 ± 0.001	1.125 ± 0.001	1.125 ± 0.001	1.125 ± 0.001
B	0.950 ± 0.002	[1]*	0.940 ± 0.002	0.943 ± 0.002
C	0.055 $^{+0.000}_{-0.002}$	0.055 $^{+0.000}_{-0.002}$	0.055 $^{+0.000}_{-0.002}$	0.055 $^{+0.000}_{-0.002}$
D[2]	0.040 $^{+0.000}_{-0.002}$	0.040 $^{+0.000}_{-0.002}$	0.040 $^{+0.000}_{-0.002}$	0.040 $^{+0.000}_{-0.002}$
E	22°30′ ± 1.5′	22°30′ ± 0.75′[3]	22°30′ ± 1.5′	22°30′ ± 1.5′
Suggested Dimensions[4]				
r	0.077	0.077	0.077	0.077
s	0.004	0.004	0.004	0.004
t	0.945		0.935	0.938
u	0.124	0.124	0.124	0.124
v	0.030	0.030	0.030	0.030
w	1.047	1.047	1.037	1.040

* Superscript numerals refer to notes on pages 2 and 3.

NOT APPROVED

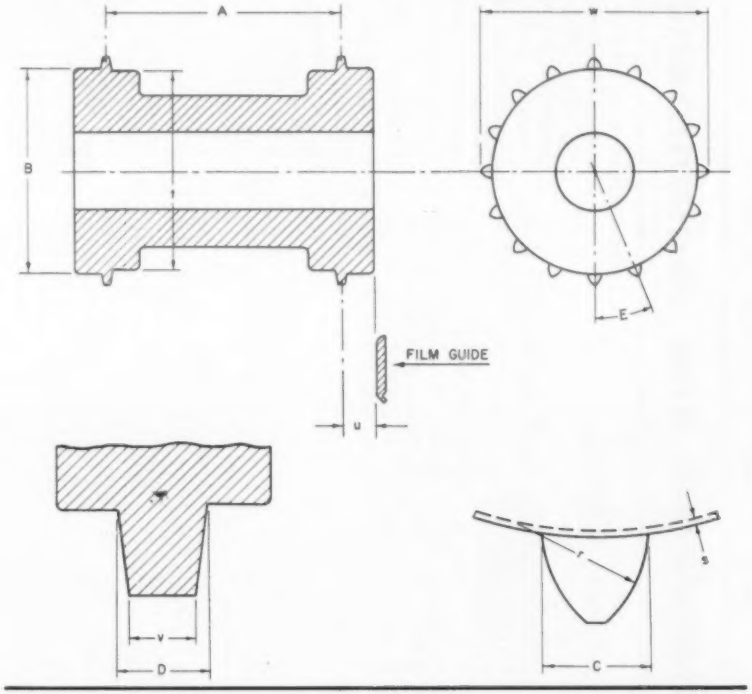
4. Revision of American Standards Referred to in This Document

4.1 When the following American Standards referred to in this document are superseded by a revision approved by the American Standards Association, Incorporated, the revision shall apply:

American Standard Dimensions for 35mm Motion-Picture Film, Alternate Standards for Either Positive or Negative Raw Stock, PH22.1-1953

American Standard Dimensions for 35mm Motion-Picture Positive Raw Stock, PH-22.36-1954

American Standard Dimensions for 35mm Motion-Picture Film, CS-1870, PH22.102-1956



Notes:

1. This dimension has an important influence upon the fatigue life of the film perforations, and upon the noise level of projector operation. The values given represent a compromise between these two objectives based upon current projection equipment, modes of exhibition, and film stocks. The B dimension for the intermittent sprocket varies in commercial practice from 0.943 to 0.953 in. The t dimension is dependent upon the dimension chosen for B.

2. This tooth width, in conjunction with other design details as specified, provides a universal sprocket accommodating with good performance all standard film perforations for 35mm projection prints.

NOT APPROVED

3. The accumulated error between any 2 teeth shall not exceed 4 minutes of arc.

4. Variations in these dimensions may be made in good practice for the purpose of changing engaging and stripping noise, accommodation for maximum film pitch tolerances, details of film indexing, etc. These suggested dimensions are given merely as an indication of one set of conditions proved in commercial use.

Appendixes

(These Appendixes are not a part of American Standard 16-Tooth 35mm Motion-Picture Projector Sprockets, PH22.35, but are included to facilitate its use.)

Appendix A

The design of film transport sprockets is based upon classic theory for the intermeshing of sprockets and chains except that correction must be made for the deformation of the film perforation under stress at the high loading rates.

Appendix B

In some instances, sprockets larger than 16-tooth (for example, 24-tooth, 32-tooth, etc) may be desirable. These sprockets are designed by providing *the same pitch relationship between film and sprocket as is delineated in this standard.*

Appendix C

Sprockets employed in sound reproducers sometimes have the dual function of film transport and stabilization. Stabilizing sprockets may require special design and their critical tolerances may differ from those for film transport sprockets.

References

J. G. Jones, "Film sprocket design," *Trans.* SMPE, 17: 55–76, Oct. 1923.

R. H. Talbot, "The projection life of film," *Jour.* SMPE, 45: 78–101, Aug. 1945.

"Report of the Sub Committee on Projector Sprocket Design," *Jour.* SMPE, 45: 73–75, Aug. 1945.

D. R. White and C. DeMoos, "A note of the projection life of film," *Jour.* SMPE, 41: 297–299, Oct. 1943.

Proposed American Standard

Dimensions for 200-Mil Magnetic Sound Records on 35mm and 17 1/2mm Motion-Picture Film

Revision of PH22.86-1953

1. Scope

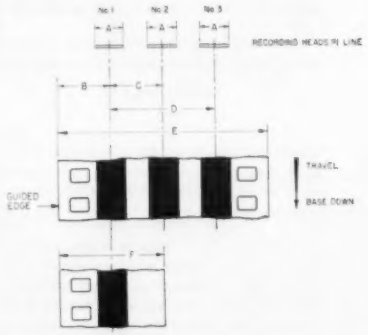
1.1 This standard specifies the locations and dimensions of magnetic sound records, both single and multiple tracks, on 35mm motion-picture film, and single tracks on 17½mm motion-picture film.

1.2 The sound records are determined by the lateral dimensions and position of the magnetic recording head.

1.3 This standard relates the placement of the magnetic coating on the film to the direction of film travel.

2. Dimensions

The dimensions and position of magnetic track No. 1 shall be determined by magnetic head No. 1, as specified in the diagram and table, and shall refer to the film immediately after cutting and perforation. The positions of tracks two and three shall be determined by the lateral dimensions of magnetic recording heads No. 2 and No. 3, as shown in the diagram.



3. Magnetic Coating

With the direction of film travel shown in the diagram, the magnetic coating shall be on the upper face of the film base.

4. Preferred Track Position

Track No. 1 is the preferred position for 35mm single-track recording and is the standard position for 17½mm recording.

5. Recording and Reproducing Speed

Recording and reproducing speed shall be 96 perforations per second [see American Standard 35mm Sound Motion-Picture Film Usage in Camera, PH22.2-1954 (note Section 6, below)]. This is equivalent to 24 frames per second (approximately 18 inches per second).

6. Revision of American Standard Referred to in This Document

When the following American Standard referred to in this document is superseded by a revision approved by the American Standards Association, Incorporated, the revision shall apply:

American Standard 35mm Sound Motion-Picture Film Usage in Camera, PH22.2-1954

Note: The dimensions in the inch system are the fundamental standard. The dimensions in the metric system are practical approximations based on American Standard Inch-Millimeter Conversion for Industrial Use, B48.1-1933, reaffirmed in 1947, which provides a conversion factor of 1 inch = 25.4 millimeters.

Dimensions	Inches	Millimeters
A	0.200 ± 0.002	5.08 ± 0.05
B	0.339 ± 0.002	8.61 ± 0.05
C	0.350 ± 0.002	8.89 ± 0.05
D	0.700 ± 0.002	17.78 ± 0.05
E	1.378 nom	35.00 nom
F	0.689 nom	17.50 nom

Proposed American Standard

PH22.126

16mm Multi-Azimuth Test Film, Magnetic Type

1. Scope

This standard specifies a test film to be used for determining the azimuth alignment of a magnetic reproducer head without disturbing its adjustment.

2. Test Film

2.1 The test film shall have an original sound record having a wave shape that is approximately sinusoidal. The frequency of the sound record shall be approximately 7000 cps when the film travel rate is 24 perforations per second (approximately 36 ft per minute).

2.2 The recording shall be made at 100 percent modulation level with a tolerance of +0 −2 db. 100 percent modulation is defined as the recording head current at which 3 percent total harmonic distortion occurs at a signal frequency of 1000 cps.

2.3 The location and dimensions of the sound record shall be as given in the diagram and in Table 1.

2.4 The sound record shall be recorded in such a manner as to produce sequential steps recorded at calibrated deviations from the perpendicular to the direction of film travel.

2.5 This test film shall have a total of 11 steps, which, when reproduced on a properly aligned reproducer, will give output indications varying from minimum at the first step to maximum at the sixth step and back to minimum at the 11th step. The sixth step shall be a recording whose azimuth is perpendicular to the direction of film travel within ±1 minute of arc. The azimuth of all other steps shall be within ±0.5 db of specified deviation for each step, as shown in the diagram and Table 1, excepting those of infinite loss.

2.6 The deviation in azimuth for the various steps shall be as shown in the diagram and in Table 2.

Table 1. Computed Signal Outputs in Decibels Relative to the Output of Step 6, For Three Widths of Playback Heads.

Step No.	Footage[1]	Azimuth	Reproduce Head Width 0.200"	0.085"	0.050"
1	0.0	40′	[2]db	−28.0db	−5.0db
2	2.5	20′	−∞	−3.5	−1.2
3	5.0	10′	−5.0	−0.9	−0.3
4	7.5	5′	−1.0	−0.2	−0.07
5	10.0	2.5′	−0.3	−0.05	−0.02
6	12.5	0′	0	0	0
7	21.0	−2.5′	−0.3	−0.05	−0.02
8	23.5	−5′	−1.0	−0.2	−0.07
9	26.0	−10′	−5.0	−0.9	−0.3
10	28.5	−20′	−∞	−3.5	−1.2
11	31.0	−40′	[2]	−28.0	−5.0

[1] Footage measured from the start of Step No. 1 to the start of the step indicated.

[2] Disregard measured values for these steps since the readings are influenced by secondary maxima.

The computed, theoretical signal outputs in Table 1 are relative to the output of Step 6, calculated from the relationship

$$\text{Output (db)} = 20 \log_{10} \frac{\sin \frac{W\theta\pi}{\lambda}}{\frac{W\theta\pi}{\lambda}}$$

where λ = Wavelength
θ = Angle of Misalignment (Radians)
W = Head Width (Reproducer)

Table 2

Step 1	= 40	minutes of arc from perpendicular
Step 2	= 20	" " " " "
Step 3	= 10	" " " " "
Step 4	= 5	" " " " "
Step 5	= 2.5	" " " " "
Step 6	= 0	" " " " "
Step 7	= 2.5	" " " " "
Step 8	= 5	" " " " "
Step 9	= 10	" " " " "
Step 10	= 20	" " " " "
Step 11	= 40	" " " " "

NOT APPROVED

3. Film Stock

3.1 The film stock used shall be of safety type, cut and perforated in accordance with American Standard Dimensions for 16mm Film, Perforated One Edge, PH22.12-1953 [note Section 6, below].

3.2 The dimensions of the magnetic coating are not specified herein but should be sufficiently wide to permit the placement of a sound record in accordance with this standard.

4. Film Length

4.1 This test film shall have a 6-foot head and tail leader.

4.2 Azimuth Step 6 shall be 8 feet in length and all others of 2-foot length, with no-signal spaces of 6-inch length between adjacent steps.

4.3 The total length of this test film, including leaders, sound record and signal breaks, shall be 45 feet.

5. Identification

Each test film shall have suitable identification markings.

6. Revision of American Standard Referred to in This Document

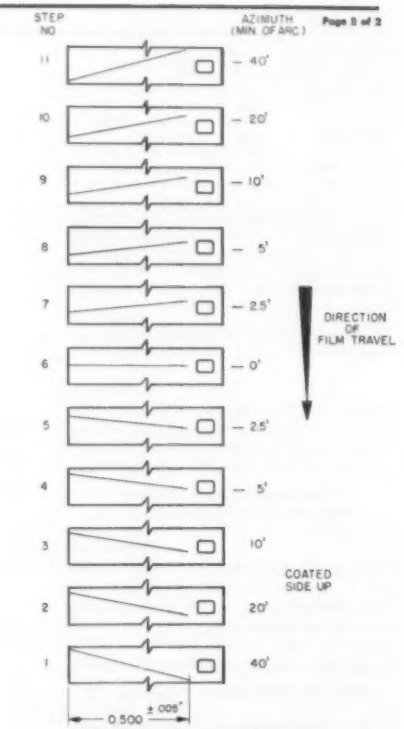
When the following American Standard referred to in this document is superseded by a revision approved by the American Standards Association, Incorporated, the revision shall apply:

American Standard Dimensions for 16mm Film, Perforated One Edge, PH22.12-1953

APPENDIX

(This Appendix is not a part of Proposed American Standard 16mm Multi-Azimuth Test Film, Magnetic Type, PH22.126, but is included to facilitate its use.)

This test film is designed to indicate whether the azimuth of a reproduce head has been set accurately, by the measurement of relative outputs from a test film of known geometry and accuracy. Step 6 on this film



has been made with true azimuth and it therefore becomes the prime reference with all other steps considered relative to it. A practical maximum error in the azimuth of the recording at Step 6 has been defined in 2.5 as 0° ± 1′; this specification therefore controls the manufacturing excellence of the test film and establishes one limit on the precision of measurements with it.

Since the user of the film will measure the relative output of the various steps in decibels deviation from Step 6, the precision of the azimuth settings for these steps is defined in 2.5 as ± 0.5 db from the relative output levels of Table 1. This figure is, therefore, a practical measure of significant variations. The manufacturer of the test film will set up his equipment in accordance with Table 2, but will determine that the film meets the performance specifications of Table 1 and 2.5.

NOT APPROVED

Exhibit

89th SMPTE Semiannual Convention

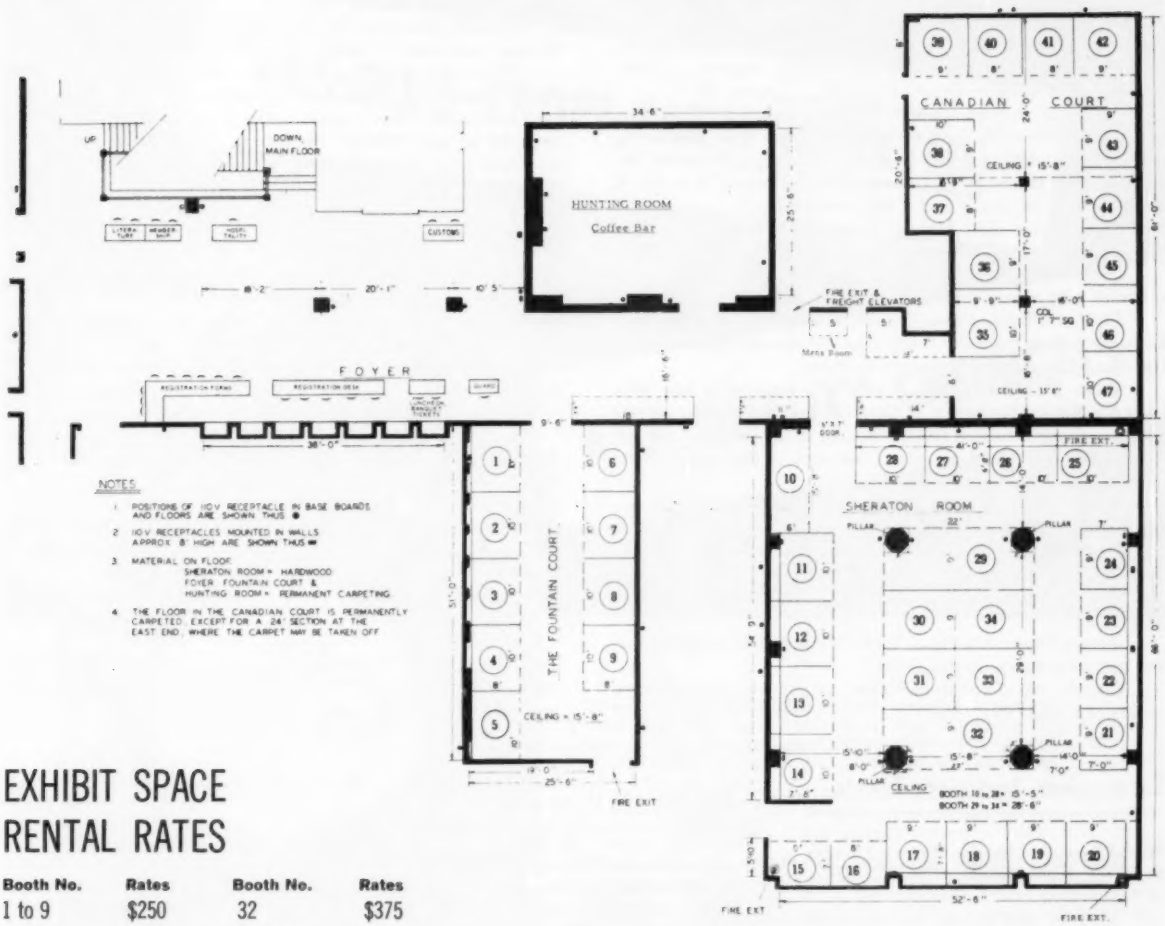


EXHIBIT SPACE RENTAL RATES

Booth No.	Rates	Booth No.	Rates
1 to 9	$250	32	$375
10	200	33 & 34	270
11 to 14	250	35	260
*15 & 16	150	36	250
17 to 24	250	37 to 42	240
25 to 28	260	43 to 45	250
29	385	46 & 47	260
30 & 31	270		

*Booths 15 & 16 are very small; therefore, both spaces will be rented as one unit for a total of $260.00.

FOR RESERVATIONS:

contact the Exhibit Chairman:

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news and reports

89th Convention Plans

Plans for the 89th Convention are well advanced, according to latest reports from Program Chairman Rodger J. Ross and other Convention planners. A special effort is being made to support the theme, *International Achievements in Motion Pictures and Television*, by a number of papers from other countries. Local Arrangements Chairman, Gerald G. Graham, recently returned from a trip to Europe, reports a lively interest in the Toronto Papers Program.

Of special interest is a detailed report received from Motion-Picture Short Subjects Chairman, Ralph Ellis, presenting a descriptive list of short subjects tentatively planned for presentation at the 89th Convention. Following is a list of titles, country of origin and a brief description:

The Cultured Ape, United Kingdom, one reel. Cartoon about an ape who plays the flute.

Insolent Matador, United Kingdom, one reel. Story of a matador who would fight only short-sighted bulls.

Night at a Peking Opera, France, two reels. Four of the best known numbers from the *Peking Opera* repertoire filmed during the visit of the Opera Company to Paris.

Trésor D'Ostende, Belgium, one reel. Story of a boy who loses his dog on the beach of Ostende, and the frantic pursuit which ends with the dog being returned to the boy.

Top Dogs, United Kingdom, one reel. A film using paper cutouts as a new type of animation.

Jonny, Germany, one reel. Story of a little German lad who is a member of a carnival family.

People of the City, Sweden, two reels. Visual interpretation of life from dawn to dusk in a Swedish city.

Tokyo Fantasy, Japan, two reels. A kaleidescopic view of Tokyo today.

Animal Parade, Australia. Views of Australian wildlife from the television series, *Animal Parade*.

Cruel Revenge of a Snake by a Trout, Japan, one reel. Macabre killing of a snake by a trout.

Capriccio, Germany, one reel. Music film displaying camera artistry of Richard Scheinpflug.

The Kitten, Antics of a kitten locked in a dining room.

Kolya (*Christmas Journey*), Russia, one reel. A little boy dreams he is visiting his father in a weather post in Antarctica, taking him a Christmas Tree.

Thinking Machines, United States, two reels. A film about human minds and the mind of a "thinking machine."

Many of these films have won awards, and all of them display particular artistry and technique.

Information about topics and a listing of Topic Chairmen appears in the October *Journal*, p. 752. All information is available from Program Chairman *Rodger J. Ross*, c/o Canadian Broadcasting Corp., 354 Jarvis St., Toronto, Canada.

Equipment Exhibit

The Exhibit Chairman, Ken Oakley, reports lively booth sales, at this early date, that foreshadow a fine display of equipment from several parts of the world. Response so far has come from companies in Canada, the U.S. and Great Britain, so that the international theme of the Convention will be sustained in the Exhibit. Among the first reservations to be received are those from:

Bach-Auricon, Inc.
Bell & Howell Co.
Caldwell A/V Equipment
Canadian Applied Research
Alex L. Clark Ltd.
Ferrania Div., Viditon Corp.
Film Editing Equipment Corp.
Florman & Babb, Inc.
Harwald Co.
Magnasync Corp.
McCurdy Radio Industries
Precision Cine Equipment
Robert Rigby Ltd.
L. B. Russell Chemicals, Inc.
S.O.S. Cinema Supply Corp.

Full details about the remaining space can be obtained from the Exhibit Chairman. See page 825 of this issue for his address and other information about the Exhibit.

Education, Industry News

World Survey of Motion Picture Theater Facilities, a publication of the U.S. Dept. of Commerce, reports that between 1955 and 1960 the number of motion-picture theaters throughout the world increased 29%. The project was under the Business and Defense Services Administration, and the report was prepared by the Scientific, Motion Picture and Photographic Products Division. Especially noted was that the decline in the number of auditorium-type theaters has been partly compensated for by the growing popularity of drive-in theaters.

Among other trends noted in the report was that the number of theaters throughout the world equipped to show 35mm films increased from 119,982 to 154,852 during the five-year period covered by the survey. During the same time, in the United States the number of auditorium-type theaters dropped from 14,301 to 12,291, but the number of drive-in theaters increased from 4,050 to 4,700. Canada also reported a substantial drop in the auditorium-type theaters and a slight increase in drive-ins.

Statistics, based on Foreign Service dispatches, cover 130 countries and territories. Other findings noted in the report: U.S. films now earn slightly more than $200 million annually abroad; an upward trend in theater building was noted in several countries, including Germany, Italy, Spain, Japan, India and some parts of Africa; the growth of television in Europe is creating a competitive situation for the motion-picture industry in Europe.

The publication is available from the U.S. Department of Commerce, Washington 25, D.C., or from its Field Offices. It is priced at 10 cents.

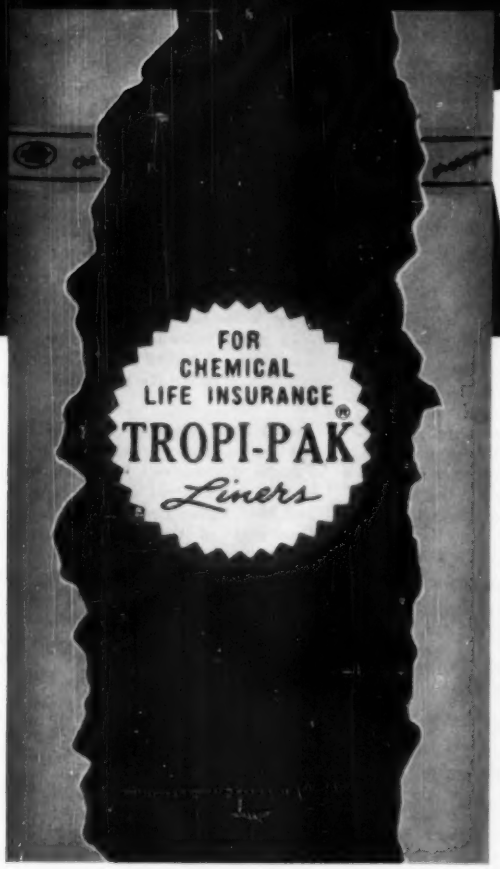
Bob Jones University, one of three universities in the United States offering a Master's degree in film production, and one of the eight offering Bachelor degrees in this field, has announced the tenth anniversary of the founding of Unusual Films, the University's Division of Cinema. During the ten years it has been in existence, Unusual Films has received many honors for its productions, among them the Silver Medallion for the Inter-Collegiate Film Competition, awarded by the Screen Producers Guild, and nine awards presented by the National Evangelical Film Foundation. One of the Division's outstanding productions, *Wine of Morning*, was selected by the University Film Producers Association to represent collegiate production in the United States at the Cannes Film Festival and in Paris. "Trademark" of Unusual Films is a flying angel bearing a camera in its arms. Director of the Division is Mrs. Gilbert Stenholm who was appointed in 1950 when the Division was established.

The Theater Arts Department of the University of California Los Angeles has announced the gift to the Theater Arts Library of a complete collection of continuity and production sketches (step-by-step visual treatments of the script) from Stanley Kramer Pictures Corporation for

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each motion picture produced by this company. The collection shows the careful pre-production design work of the Kramer organization under the supervision of Production Designer Rudolph Sternad. It will be housed in the Theater Arts Library for study by students of direction, editing and production design.

Nationwide use of television in the public schools is reported for the school year 1958–59 by the Fund for the Advancement of Education. Reports on controlled experiments establish many advantages of education by television. Copies of the report are available without charge as long as the supply lasts from The Fund for the Advancement of Education, 477 Madison Ave., New York 22, N.Y.

Use of closed-circuit television for highway traffic surveillance was demonstrated at the National Auto Show held during October in Detroit by General Electric Co. in cooperation with Michigan State Highway Department and Michigan Bell Telephone Co. An experimental closed-circuit system was built by General Electric for the highway department to implement remote electronic control of a 3.2-mile segment of the John C. Lodge Freeway. One transistorized closed-circuit camera (Type TE-9-A) was used in the experiment and 14 of the cameras are expected to be installed along the freeway at a later date to provide continuous surveillance of the freeway and to present visual information to aid in effective regulation of entrances, exits, lanes and speeds.

Two new TV stations in Montreal, one to broadcast in French and the other in English, are scheduled to go on the air in 1961. Both stations' transmitter facilities will be housed in the same building on top of Mount Royal mountain in the heart of Montreal. Equipment supplied by Marconi's Wireless Telegraph Co., Chelmsford, Essex, England, includes two 18-kw vision and 9-kw sound transmitters operating in parallel for each channel. The vision equipment consists of 4-kw BD366 transmitters driving 18-kw amplifiers (BD369), and the sound equipment consists of 1-kw transmitters (BD317) with 10-kw amplifiers (BD360). The transmitters are suitable for color television.

Subscription Television: Plans for conducting an extensive three-year test of subscription television in Hartford, Conn., using Zenith Radio Corp.'s Phonevision system, although still contingent upon FCC approval, are shaping up rapidly. The Hartford Phonevision Co., a subsidiary of RKA General, Inc., has been formed to conduct the test. Reports are that the sum of $10 million has been pledged for expenditures during the three-year testing period. In another development, Teco, Inc., an Illinois corporation, has been licensed by Zenith to engage in subscription television operations using the Phonevision system. The Illinois firm would be engaged in programming activities and would be one of the program suppliers for the Hartford test.

A mobile television studio contained within a 40-ft bus has been equipped by Radio Corp. of America for Video Tape Unlimited, Inc., of New York. Designed for broadcasting from both readily accessible and remote locations and for making tape recordings of moving events, such as parades, it provides facilities for producers of TV shows, commercials and closed-circuit presentations. Technical equipment includes four RCA image-orthicon tape recorders, special effects system, generator, audio-tape facilities, record turntable and other broadcast devices, including lighting equipment and reflectors.

Installation of a two-channel telecine system in the London advertising agency of Hobson, Bates and Partners Ltd. has been announced by Marconi's Wireless Telegraph Co., Chelmsford, Essex. The installation is based on the simplified Vidicon Telecine Channels (Type BD 884). Both cameras can be used for either telecine or live work. When in use for telecine, one camera is mounted on a turntable so that it can be rapidly aligned to receive pictures from a 35mm, 16mm or slide projector. The projectors are also available for normal projection onto the motion-picture screen. The second camera is normally aligned to another 35mm projector.

Either or both of the cameras can be removed from their telecine mountings and used for live work in an adjoining studio. A comprehensive switching arrangement allows any of twelve sources of sound to be connected to one or more of the outgoing television channels (telecine Channel III, telecine Channel V, theater loudspeakers or studio loudspeaker). Pictures from either or both of the cameras, or from BBC and ITA aerials, are distributed to a number of normal TV receivers situated in various offices around the building.

The system makes it possible to run a live television show using two cameras, with the ability to cut from one camera to another, or to show two films simultaneously on two separate telecine channels, or even to show one film on telecine while another film is being shown in the theater, and the second TV camera is being used in the studio.

A brief report on film and TV activity in Japan during the first half of 1960 appears in the July issue of the *Motion Picture Engineering Journal of Japan*. According to the report, 278 feature films were produced in the six-months period, representing an increase of 3.2% over production during the first six months of 1959. Fourteen theaters in various cities have been equipped for the exhibition of 70mm films. Reports on television show more than 5 million sets in Japan. Test broadcasting of color TV by the NTSC system was undertaken about two years ago by the Nippon Hoso Kyokai — Japan Broadcasting Association, and the Nippon Television Network, Inc. Increased production or color programs is planned for the near future.

The Grand Prix and the Silver Medal of the Netherlands International Student Film Festival has been awarded to a University of California Los Angeles student-produced film. The film, *Time Out of War*, was cited as the best student-produced film made anywhere in the world during the last ten years. The film was directed by Denis Sanders in 1955 who, at that time was candidate for an M.A. degree at UCLA, and it was photographed by his brother, Terry Sanders. The subject matter of the film concerns an incident of the Civil War when Confederate and Union soldiers halted hostilities for an interlude of friendliness. The same film had previously won other honors including an Academy Award and a prize at the Venice Film Festival.

N. D. Golden and **Paul Cherney** were presented with two of the ten silver plaques awarded by the City of Cologne upon the occasion of the tenth anniversary of Photokina. These two were the only Americans thus honored. Mr. Golden is Director of the Photographic – Scientific Instrument Division of the U.S. Department of Commerce. Mr. Cherney is affiliated with Cinefot International Corp., New York. The citations emphasized their contributions toward closer and improved relations among the photographic and optical manufacturing companies of the world.

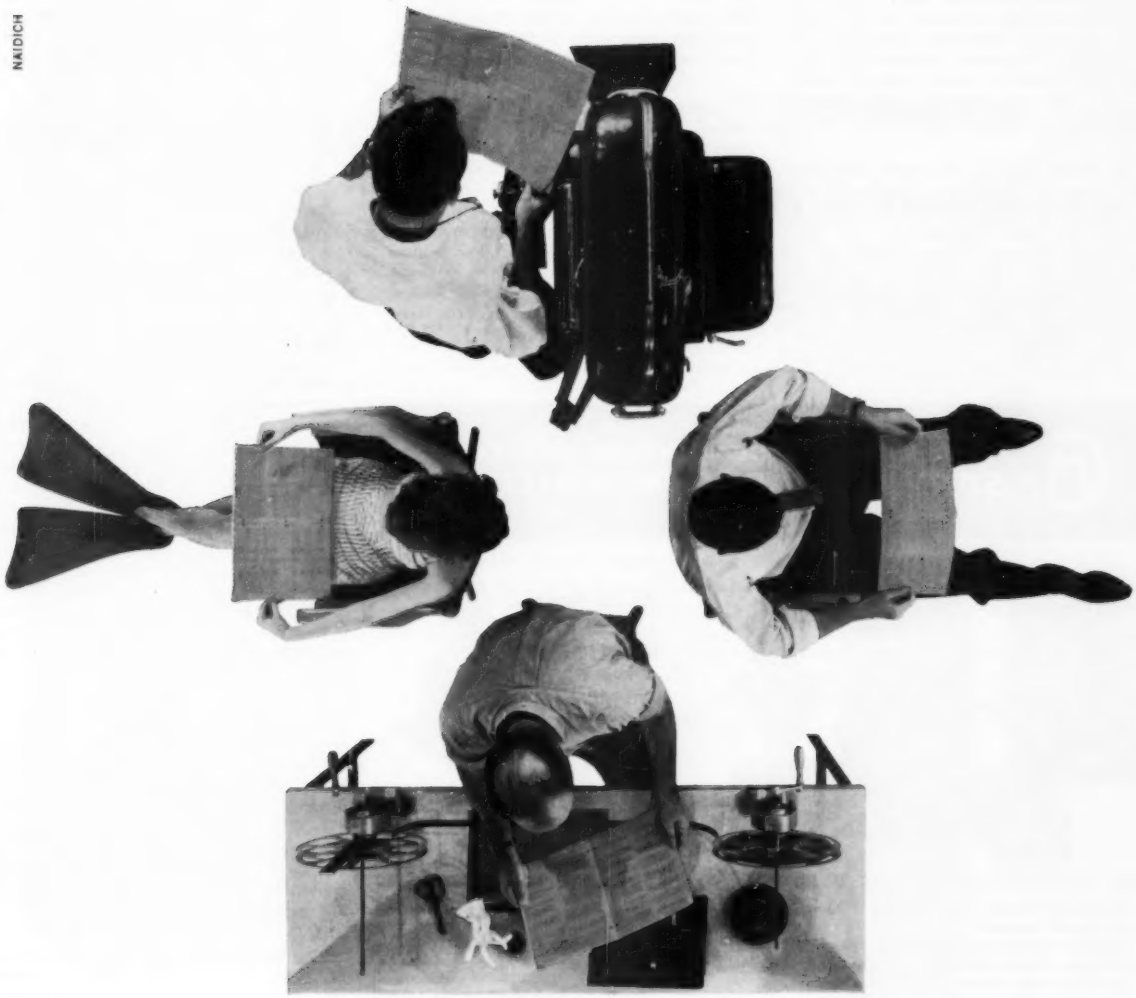
A video-tape production edited electronically from scenes made at different locations has been announced by Reeves Sound Studios, a division of Reeves Broadcasting & Development Corp. Various parts of a show called *Excite-Ability* were recorded on tape at different times in Detroit and Hollywood. Scene continuity was determined and timed, then assembled and spaced out on four different tapes. These were then mixed electronically into one composite video tape. Anthony Termini, President of Termini Tape Services, directed the electronic editing.

Jack Kirsch has been elected President of the Allied States Association of Motion Picture Exhibitors. He had previously served as President of the group in 1946 and 1947. Other newly elected officers are: Chairman of the Board, Ben Marcus, Milwaukee; Treasurer, Harry Hendel, Pittsburgh; National Secretary, Richard Lochry, Indianapolis; Regional Vice-Presidents — James L. Whittle, Baltimore; Marshall Fine, Cleveland; Milton London, Detroit; Edward E. Johnson, Milwaukee; and Neil Beezley, Burlington, Colo.

Herbert P. Michels has been appointed East Coast Sales Manager for Foto-Video Electronics, Inc., 30–36 Commerce Rd., Cedar Grove, N.J. He became affiliated with the firm in 1959, serving as Engineering Sales Representative in the New York City – New Jersey area. He was formerly associated with the commercial broadcast station organization of Cornell University where he was Director of Engineering.

Frederick G. Ramback has been appointed National Sales Manager for Ampex Professional Products Co. In his new position he will direct sales activities for

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Two newly created executive positions have been announced by Westrex Corp., a division of Litton Industries. Anthony Easton has been appointed to the new position of Director of International Sales, and Harry M. Rich has been appointed Manager of the New Import Department. The firm presently maintains 34 main foreign offices, 34 supplement offices and 160 service centers serving 50 countries. Operations are also carried on through 18 subsidiary companies with offices in 18 countries throughout the world.

A new Eastman Kodak Co. affiliate, known as Kodak Ges. m. b. H., has been established in Austria, with headquarters in Vienna. It succeeds the Johann Kraus firm which has been the Kodak distributor in Austria since 1948. The new firm was established following the retirement of Johann Kraus, head of the firm which bore his name. Peter O. Schmidt is manager of the new Kodak Austria. Other persons with the Johann Kraus firm have continued with the new firm.

A. N. Brown has been appointed Marketing Manager of the Nomad Division of Magnasync Corporation. Prior to this appointment he was Vice-President in charge of sales for Bach-Auricon, Inc.

A program of expansion in the animation field has been announced by A. G. S. & R. Photo Studios. As part of the program, the firm has acquired an Oxberry Animation Stand designed for the firm to fit its special requirements. New personnel, including two field representatives, Elliot Kallish and Fred Yochim, have been added to the firm's staff.

The Polytechnic Institute of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y., has announced that the eleventh in a series of International Symposiums will be held April 4–6, 1961, at the Engineering Societies Building, 33 W. 39 St., New York. Theme of the Symposium is Electromagnetics and Fluid Dynamics of Gaseous Plasma. The area of interest covers collective electromagnetic and fluid dynamic phenomena and their self-consistent analytical description in the temperature range characteristic of the transition between partially and fully ionized gaseous plasmas. Co-sponsors are the IRE, Institute of Aeronautical Sciences, and the U.S. Defense Research Agencies.

For the New York Worlds Fair, three firms, Ebasco Services, Inc., Vandeburg-Linkletter Associates, Inc., and Walter Kidde Constructors, Inc., have announced formation of V.E.K. Associates Inc. The new firm will provide exposition services and facilities for exhibitors at the Fair to begin in 1964. Services will include exposition planning, management, design and construction.

White noise generators; sound level and objective noise meters and indicators; AF analyzers; microphones; high-speed level recorders; impact noise and octave band analyzers; and acoustic calibrators are among the instruments for the measurement and analysis of noise produced by the British firm of Dawe Instruments Ltd. These instruments are available in the United States from Korfund Co., 48-15 32d Place, Long Island City 1, N.Y.

Richardson-Bowlds, Inc., has acquired the complete line of animation photographic equipment and accessories manufactured by the Bowlds Engineering Co., as part of an expansion program with emphasis on continuing manufacture and design of this type of equipment. The facilities of the California firm of Richardson Camera Co., will be used in the production of the new line of equipment. The firm is located at 2526 N. Ontario St., Burbank, Calif.

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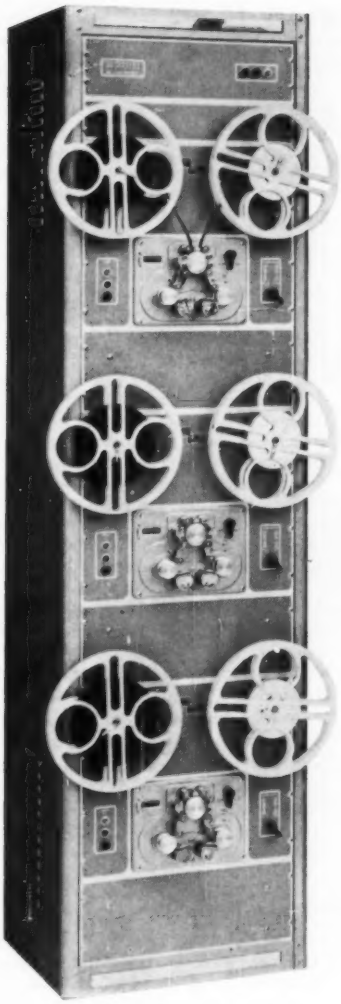
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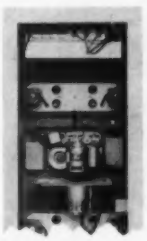
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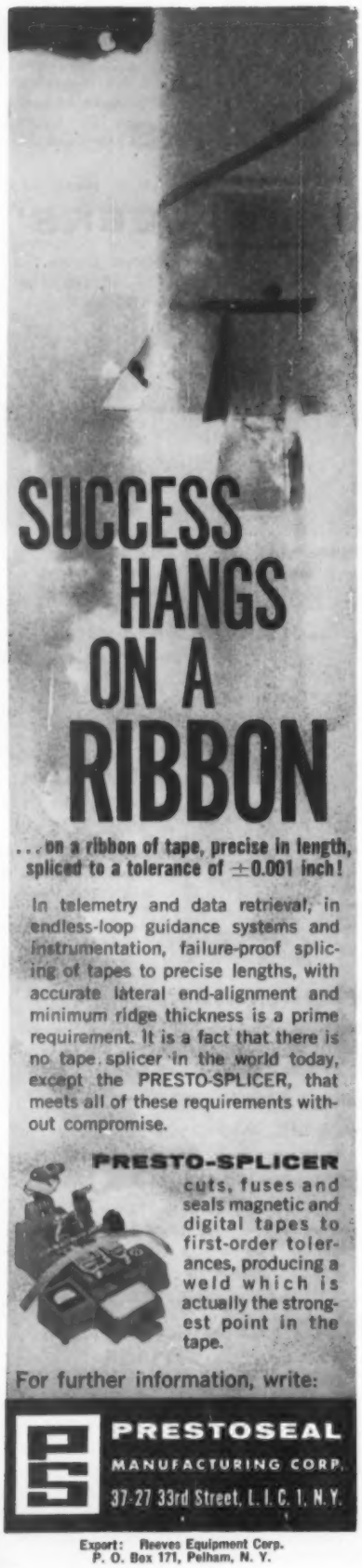
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American Society of Photogrammetry

The American Society of Photogrammetry (ASP), 1515 Massachusetts Ave., N.W., Washington 5, D.C., organized in 1934 to promote the (then) new and limited science, has recently widened its interests to include the interpretation as well as the measurements of photographs. Defined as the science of obtaining quantitative data on objects from their photographic images, the development of photogrammetry has been related directly to improvements in photography and allied instrumentation. There are three general categories of photogrammetry — terrestrial, aerial (measurement and interpretation of photographs taken from airborne cameras), and stereo. In the latter category, overlapping pairs of photographs are observed, measured, or interpreted in a stereoscopic viewing instrument which gives a three-dimensional view.

ASP, a member of the International Society of Photogrammetry, has held an annual convention each year since its founding. Papers presented explore various phases and new applications of photogrammetry. Recent conventions have been held in Washington, D.C., during the month of March. The 27th convention is scheduled for March 19–25, 1961, at the Shoreham Hotel, Washington, D.C. The 26th Convention held during March, 1960, included a Symposium on Infrared and Radar Photo Interpretation. Papers presented at other sessions discussed photogrammetric techniques associated with global surveys and satellite photography as well as new approaches to such techniques as analytical triangulation and stereoscopic plotting. Among the numerous applications of photogrammetry, other than map making, are in the fields of geographic exploration, military reconnaissance, geology, forestry, agriculture, crime detection and meteorology. One of its uses is that of providing accurate measurement information on phenomena of short duration or events occurring in inaccessible environments.

Officers on the ASP Board of Direction for 1960 are: President, G. C. Tewinkel; First Vice-President, Arthur J. McNair; Second Vice-President, James P. Webb; Secretary-Treasurer, C. Earl Palmer; Editor, Theodore W. Norcross.

The organization publishes a monthly journal, *Photogrammetric Engineering*. This journal is sent to members as part of membership privileges. Subscription rate to nonmembers is $6 annually ($6.50 outside the United States). Subscriptions and membership information are available from the ASP Washington, D.C., headquarters, noted above.

Two current publications of the ASP are: *Manual of Photographic Interpretation* (800 pp. — 600 black-and-white and color plates); available from the American Society of Photogrammetry, Att. Deputy Chairman, PI Manual Sales Committee, 1515 Massachussetts Ave., N.W., Washington 5, D.C., at a price of $12 to members and $15 to nonmembers; and *Manual of Photogrammetry* (2d ed.) (876 pp. — 300 illus.), available from the same address at a price of $7.50 to members and $12.50 to nonmembers.

section reports



The Atlanta Section met on November 1 at WSB-TV with an attendance of 17. Major T. W. Gavey, Operations Officer, 1370th Photo Mapping Wing, Turner Air Force Base, Georgia, was the guest speaker. His subject was "Aerial Mapping and Photography."

Major Gavey's group has the primary purpose of providing data for pinpointing the location of every conceivable strategic spot in the world. Unfortunately, at the present time, there are many such places whose location relative to datum points within the U.S. are not known within 35 miles. Until these points are more accurately located by aerial surveying or other methods, the manned bomber will be a vital part of our defense. Even an intercontinental missile with an inherent accuracy of one mile will not be of much value if there is an inaccuracy of 35 miles in aiming it.

Major Gavey's group is unique in the free world in gathering this information by aerial photo mapping and surveying, although there are some other means of obtaining the required information.

Major Gavey described how they obtain their data by precision aerial mapping photography, electronic geodetic surveys, and a combination of the two techniques, aerial electronic-controlled photography. He showed also how contour maps are made from aerial photo mosaics.

The speaker's address was well illustrated with color slides. An aerial photo mosaic of the Atlanta area and the contour map made from this mosaic were on display. An interesting question-and-answer period followed Major Gavey's talk.— W. R. Sandell, *Secretary-Treasurer*, c/o Kodak Processing Lab., 4729 Miller Dr., Chamblee, Ga.

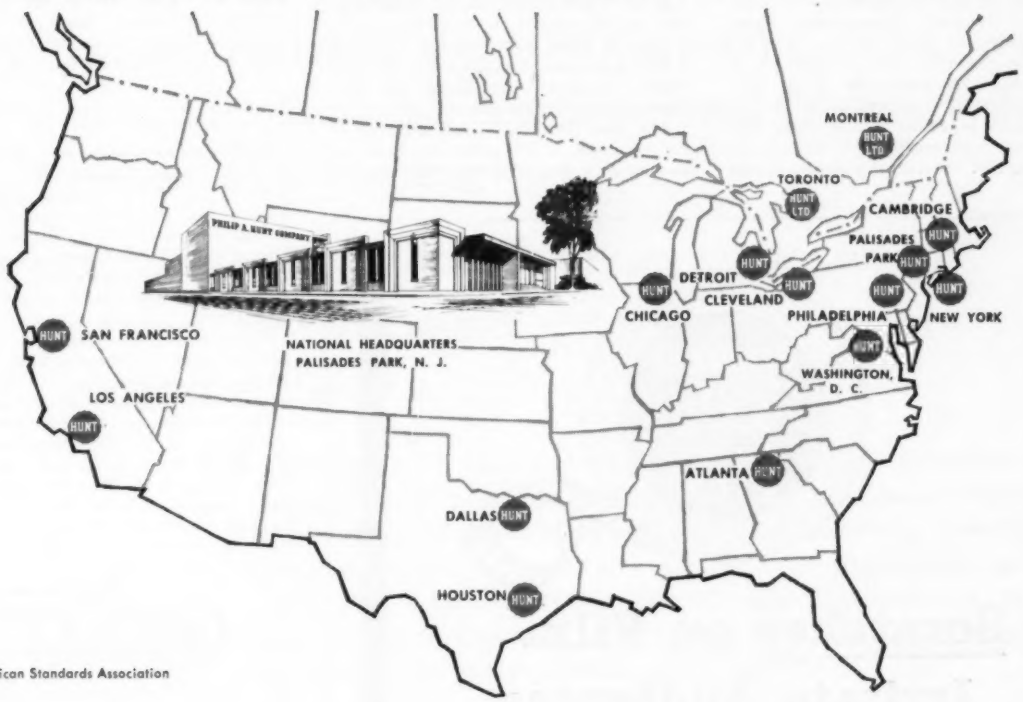
The Dallas-Fort Worth Section met on September 22 at the Mercantile National Bank Auditorium in Dallas with an attendance of 40. Guest speakers were Bruce Jameson, Jameson Film Co.; R. K. Keitz, Keitz & Herndon; and Marty Young, Motion Pictures, Inc.

At this meeting the Section instituted a program that it hopes to make an annual affair. Film producers from the area were asked to present films that have won recent awards or national recognition and to present short talks describing the problems encountered in making the films. The program contained a variety of films, and

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the audience was very enthusiastic about the Section's first "Film Festival."

Advertising executives from the area were guests at this program at which training films, sales films, television commercials and theatre advertising films were shown.—M. D. McCarty, *Secretary-Treasurer*, 4401 Wildwood Rd., Dallas, Texas.

The Hollywood Section met on October 18 at the Academy Awards Theatre with an attendance of 250. John Wentworth of Radio Corp. of America, the guest speaker, discussed "Compatible Color Television."

Mr. Wentworth, who is Manager of Educational Electronics for RCA, presented an excellent tutorial lecture covering the basic principles of compatible color television. Augumenting his verbal description, Mr. Wentworth showed approximately 80 color slides depicting in block diagram form the various concepts which combine to transmit color images from a TV studio to a home viewer's receiver.

An excellent 35mm color film produced by Disney and titled, "Man in Space," was shown as an opening feature of the program.—Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64.

The New York Section met on October 5 at the World Affairs Center Auditorium with an attendance of 76. Guest speaker Rodger J. Ross, Supervisor of Technical Film Operations, Canadian Broadcasting Corp., discussed "Improving the Performance of Television Films."

Mr. Ross presented a demonstration of the essentials of his paper by means of simultaneous projection of a film and its waveform monitor characteristics. He showed that by carefully calculating the original camera exposure on the basis of black-and-white reference and matching this to the gray-scale characteristics of the telecine reproducer, the best possible gray-scale transfer may be obtained. He stressed the need of standardization of the telecine reproducer characteristics as the first step in the direction of a more realistic approach to TV film.

After Mr. Ross presented his paper, coffee was served before the discussion period took place.—James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Labs, Inc., 619 West 54 St., New York 19.

The Rochester Section met on October 28 at the Dryden Theatre with an attendance of 81. R. J. Roman of Eastman Kodak Co. discussed, "The Kodak 8 Sound Projector." R. A. Colburn of the George W. Colburn Laboratory, delivered a "Progress Report on the Production of 8mm Color Release Prints with Magnetic Sound."

This meeting, devoted to a very important phase of motion-picture business, afforded an excellent opportunity to learn first hand the advances made recently in 8mm film presentation. These timely developments of the film, projector-sound recorder, printing techniques and processes necessary to effective showing of sound pictures on 8mm film will have a marked impact on the growth of 8mm business, according to views expressed by several who attended.

Mr. Roman described construction details of and demonstrated the new Kodak 8 Sound Projector. The excellent sound reproduction quality capabilities of the projector were made apparent by playback of the magnetic soundtrack at both 16 and 24 frames sec through the facilities of the speaker system in the theatre. On-the-spot recording and playback through the projector self contained amplifier speaker system was also accomplished with good fidelity. The paper authored by Messrs. Roman, Moriarty and Johnson on the subject projector, and read by Mr. Roman, described several interesting features of the projector.

According to Mr. Colburn, advances in 8mm film production techniques, particularly in reduction printing and magnetic sound recording, made by the Colburn Laboratories, have contributed much to the art. He gave an interesting review of the history of developments and application of new films as well as of equipment now available. Slides showing printing and related equipment used in the laboratory for film production and the demonstration 8mm motion picture pointed up the efforts put forth to make possible good presentations in this important field.

The meeting was opened with the showing of a film on *Carbon Arc Projection*, by the National Carbon Co. This well made film shows the why of the high intensity "white light" carbon arc.

Prior to the meeting, Section Chairman Connor and other officers of the Section had dinner with the speakers and guests.—W. G. Hill, *Secretary-Treasurer*, 10 Hillcrest Ave., Binghamton, N. Y.



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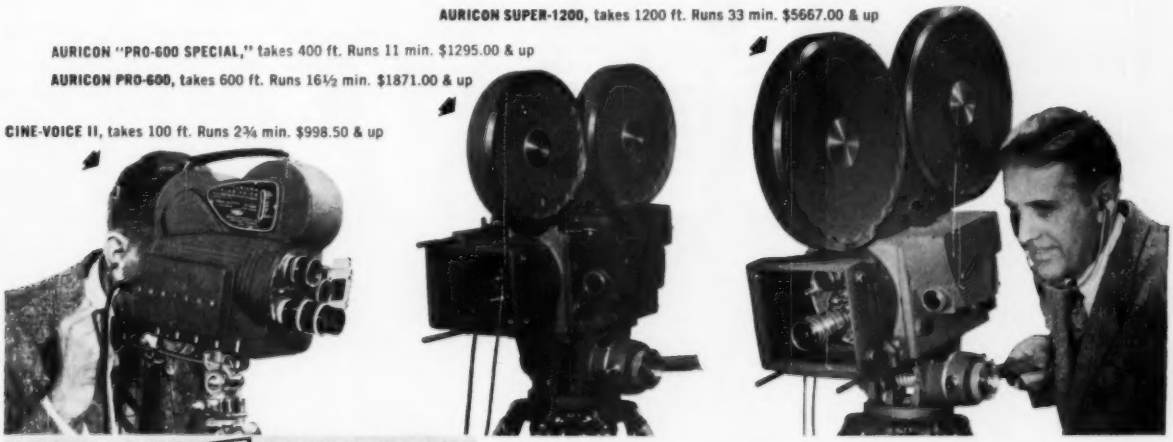
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Obituaries

Hollis W. Moyse

Hollis W. Moyse, 57, died July 22, 1960, at his home in Hollywood. A Fellow of the Society, his entire career was devoted to perfecting the art and science of motion-picture photography. In 1924 he affiliated with Technicolor Motion Picture Corp., and four years later accepted a post with E. I. du Pont de Nemours & Co., Parlin, N.J., where he engaged in research and development work on motion-picture films and emulsions. In 1932, he was transferred to Hollywood as the firm's Motion Picture Technical Representative.

Among many other achievements he contributed greatly to the development of the fine-grain sound films which won an Academy Award. The Award was presented jointly to du Pont and Paramount Pictures Corp. The films are described in a paper published in the October 1945 issue of the *Journal*, "Du Pont Fine-Grain Sound Films — Types 232 and 236," authored by Mr. Moyse. Other Society activities in which he engaged include service on the Board of Governors and as Chairman of the (then) West Coast Section. He was also a member of the American Society of Cinematographers, the Academy of Motion Picture Arts and Sciences, and the Society of Photographic Instrumentation Engineers.

W. R. G. Baker

W. R. G. Baker, an internationally recognized pioneer in radio and television, died October 30 at his home in Syracuse, N.Y., at the age of 67. At the time of his death he was Vice-President for Research of Syracuse University, a post to which he was appointed following his retirement from the vice-presidency of General Electric Co. He was born in Lockport, N.Y., and in 1916 he was graduated from Union College with the degree of Bachelor of Science in Engineering. Two years later he was granted the degree of Master of Science. He held honorary degrees from Union College, Syracuse University and Brooklyn Polytechnic Institute.

He joined General Electric in 1917 and in 1930 he went to Radio Corp. of America as head of radio engineering activities. In 1935 he returned to general Electric. In 1939 he founded General Electric's pioneer TV station, which bears his initials, WRGB-Schenectady. In 1959 he was awarded SMPTE's David Sarnoff Gold Medal (*Jour.*, p. 848, Dec. 1959) in recognition of his many achievements and especially for his work as Chairman of the National Television Systems Committee which functioned on two separate occasions when standards were urgently needed, first for monochrome television and later for color television.

During his long and distinguished career he received many honors, among them the IRE Medal of Honor and the Medal of Honor of the EIA. He was honored by both the Army and the Navy for his contributions to military electronics during World War II. He was a member of many technical organizations, holding office in many of them.

current literature



The Editors present for convenient reference a list of articles dealing with subjects cognate to motion-picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

Bild und Ton vol. 13, July 1960

Die entwicklung der Unterwasser-Kinematographie (p. 208) *U. K. T. Schulz*

International Projectionist vol. 35, July 1960

Structure and Properties of Release-Positive Films (p. 4) *R. A. Mitchell*

Jour. Biological Photographic Association

vol. 28, Feb. 1960

Video Microscopy With Closed Circuit Television at the University of Washington Health Sciences Division (p. 15) *Clifford L. Freehe*

Jour. Brit. IRE vol. 20, Aug. 1960

Operational Facilities in the RCA Colour Television Tape (p. 611) *A. H. Lind*

A Tunnel Diode Crystal Calibrator (p. 621) *L. G. Cox*

Recommended Method of Expressing Electronic Measuring Instrument Characteristics 5. (p. 625) *A. C. Bridges*

vol. 20, July 1960

The Work of the British Standards Institution in Relation to the Radio and Electronics Industry (p. 487) *H. A. R. Binney*

A Mobile Television Camera and Recording Vehicle (p. 553) *Aubrey Harris*

vol. 20, June 1960

Industrial Television: A Survey of History, Requirements and Applications (p. 441) *J. E. H. Brace*

Application of Industry and Science in the U.S.S.R. (p. 449) *V. I. Sardyko*

vol. 20, May 1960

Video-Frequence Equipment for Television Centres of the Soviet Union (p. 381) *B. A. Berlin*

Jour. Radio Research Laboratories

vol. 6, July 1959

A Possibility of the Long Distance HF Propagation Along the Exospheric Field-Aligned Ionizations (p. 603) *T. Obayashi*

Kino-Technik vol. 14, July 1960

Mikro-Kinematographie in Wissenschaft und Technik (p. 200) *L. Reumuth*

Fortschritte der Röntgen-Kinematographie mit dem Bildverstärker (p. 203) *H. Uhl*

Aufnahmegerät zur gleichzeitigen Aufzeichnung einer Mitten-und Randspur auf perforiertem 16-mm-Magnettonfilm (p. 205) *A. Hinze*

vol. 14, Aug. 1960

Zur Frage des Pulsbetriebes von Xenon-Lampen für die Kinoprojektion (p. 221) *H. Grahner*

Photo Ciné Revue May 1960

Les transformations du cinéma au XXV Salon Photo-Cinéma-Optique 1960 (p. 139) *P. Hemardinquer*

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June 1960

Les progrès des projecteurs et de la sonorisation au XXV Salon Photo-Cinéma-Optique (p. 170) *P. Hemardinquer*

July 1960

Les progrès des projecteurs et de la sonorisation au XXV Salon Photo-Cinéma-Optique (p. 194) *P. Hemardinquer*

The Photographic Journal

vol. 100, No. 7 (1960)

Audio and Video Magnetic Recording and Reproduction (p. 231) *J. M. Carson*

Photographie u. Wissenschaft

vol. 9, No. 1 (1960)

Die Operations-Kinematographie (p. 15) *H. Orbach*

vol. 107, July 1960

Proc. Institution of Electrical Engineers: Pt. B

Development of the Formulae of Electromagnetism in the M.K.S. System (p. 331) *P. Vigoureux*

An Introduction to the Theory of Solid-State Masers (p. 341) *P. N. Butcher*

Some Mechanisms of Failure of Capacitors With Mica Dielectrics (p. 357) *A. A. New*

Extra-Terrestrial Radio Noise as a Source of Interference in the Frequency Range 30-1000 Mc/s (p. 373) *F. Horner*

The Long-Term Stability of Fixed Resistors (p. 377) *H. F. Church*

vol. 107, May 1960

A Quadrature Network for Generating Vestigal-Sideband Signals (p. 253) *G. G. Gouriet* and *G. F. Newell*

Tekhnika Kino i Televediniya

No. 7 (1960) (In Russian)

On the Problem of Cinema Stereoscopic Development (p. 1) *B. T. Ivanov*

Research of 35mm Projector with Intermittent Film Travelling Optical Alignment (p. 39) *L. G. Tarasenko*

On the Stereophonic Sound Reproduction Channel Number in Wide-Gauge Cinematograph (p. 49) *B. F. Natarov*

No. 6, 1960

A New Contact Continuous Printer for 35 and 16 mm Films and Microfilms *O. V. Pestchansky* (p. 71)

Proc. Inst. Electrical Engineers

vol. 107 pt. B No. 35, Sept. 1960

Thermistors, their Theory, Manufacture and Application (p. 389) *C. F. Powell*

Resistive Film Milliwattmeters for the Frequency Bands 8.2-12.4 Gc/s, 12.4-18 Gc/s and 26.5-40 Gc/s (p. 427) *I. Lemco* and *B. Rogal*

A Slot-Excited Corner Reflector for Use in Band V (610-960 Mc/s) (p. 431) *D. J. Whythe* and *K. W. T. Hughes*

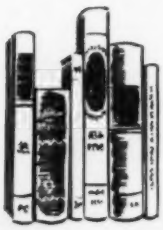
Diffusion of Sound in Small Rooms (p. 439) *K. E. Randall* and *F. L. Ward*

The Design of Controlled Rectifiers Using Triode Transistors (p. 473) *E. E. Ward*

The Conductivity of Oxide Cathodes: Pt. 9 — Thermo-electric Power. Monograph No. 397 E (p. 484) *G. H. Metson* and *M. F. Holmes*

Limitations of Realizable Response Shapes for Certain Wide-Band Band-Pass Amplifier Circuits. Monograph No. 400 E (p. 484) *R. A. Woodrow*





books reviewed

Proceedings of the International Colloquium on Cinematographic Techniques (in French)

Published (1960) by the High Technical Commission of the French Cinema, 92 Champs-Elysees, Paris 8e. 190 pp. with illus., 8¼ by 11¾-in.

The High Technical Commission of the French Cinema organized in 1955, on the occasion of its tenth anniversary (and the 60th in the history of cinematography) an international colloquium on cinematographic techniques. This was repeated in 1956 in Rome, in 1957 in Warsaw, and returned to Paris in June, 1959. Representatives from 18 nations (including some "iron-curtain" countries) attended. One representative was from our own SMPTE.

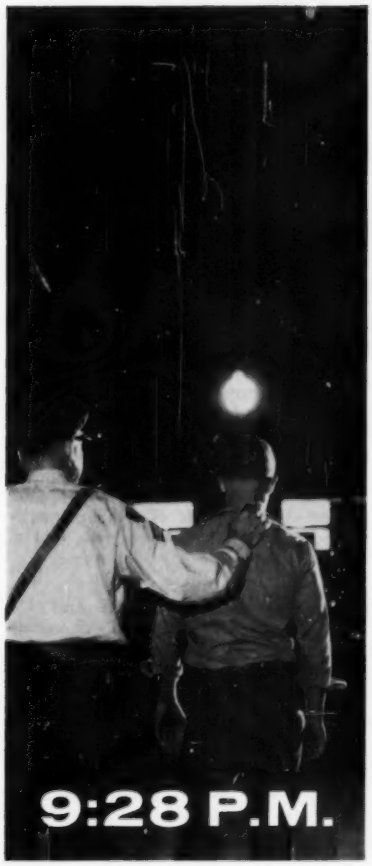
The major topics in 1955 were the wide screen, magnetic and stereophonic recording, and color. These topics remained in 1959, though new aspects of them were discussed. New topics, such as sources of light and automation, have been added. The formal listing is: Films and formats; Sources of light and projection optics; Sound reproduction; Theaters and cinema automation; and Camera exposure, sound recording and laboratory processing.

Most of the discussion is tutorial, but there are some new contributions. Some interesting topics are a listing of professional color films, a sharply pulsed high-pressure arc to give 3 projections per frame without shortening pull-down time, a high-pressure xenon arc, a pulse method of acoustic testing, some British discussions on screen luminance (now expressed in "nits," which are candels per square meter), and a variety of automation systems for projection, processing, and exposure.

It is interesting, among other things, to read that in Bulgaria the present number of motion picture theaters is six times that in 1944, that new theaters are opening at the rate of 100 per year, against nine per year in 1944; and that the number of spectators has risen since then from 15 to 90 million per year.—*Pierre Mertz*, Lido Beach, L.I., N.Y.

An Ansco Photographic Data Sheet describing Super Anscochrome PNI 16, 35, and 70mm is available upon request from Ansco, Binghamton, N.Y. The film, Daylight and Tungsten Types, is a reversal type high-speed color film. Also available upon request is a sheet listing motion-picture laboratories processing 16mm Anschrome PNI films of all emulsion types.

33 MINUTE SCOOP!







ROCK ISLAND, ILL.—With an alert on-the-spot cameraman plus speedy film processing, WHBF-TV recently telecast motion picture coverage of a local criminal capture only 33 minutes after the event.

At 9:28 p.m. an alert WHBF-TV newsman shot the action and rushed to the station. By 9:40 the film was started through their Labmaster film processor. And at 10:01 this film was lead story on the regular WHBF-TV Sunday night newscast.

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Beyond the Planet Earth

By Konstantin Tsiolkovsky (Trans. by Kenneth Syers). Published (1960) by Pergamon Press, Inc., 122 E. 55 St., New York 22. 190 pp. 8 by 5¼-in. Price $3.75.

This is a curious little book, its main interest being in the circumstances of its writing and publishing, although the content stands up very well in comparison with much contemporary "science fiction." Written at the turn of the century in Russia by a man who in 1883 was drawing designs for "space ships" which embodied many of the principles on which present day designs are based, it was published in 1920. The plot, or theme, is the now-familiar science fiction standby, the journey to the Moon, told with careful detail and a great deal of scientific explanation.

As the book begins, "Six men, a Frenchman, an Englishman, a German, an American, an Italian and a Russian," were living in a "fine castle" where they were all devoting their lives to scientific pursuits. The stage is set when, "Ivonov, the Russian, suddenly rushed into the room and started hugging everyone in turn. . . ." It seems that he had "invented something—something terrible!" Helmholtz, the German, "who had suffered worse than the rest of them from the Russian's embraces," persuaded him to reveal his invention. It develops that he has invented a rocket that will enable them to land on the Moon in four days. Whatever allegory may have been intended by the author, the rest of the book is a pure adventure tale, describing how the friends cope with space problems, explore the moon, discover interesting asteroids, found a self-sustaining colony in a space ship, and finally return to Earth where they spend their days in "a peaceful life of rational pursuits." The language of this rather charming little book is more than slightly reminiscent of the Rover Boys, but it is obvious that the author was mainly intent on presenting some of his own scientific findings and predictions in the guise of fiction.

ABC of Film and TV Working Terms

By Oswald Skilbeck. Published (1960) in Great Britain by Focal Press Ltd., available in the United States from Hastings House, Publishers, Inc., 151 E. 50 St., New York 22. 160 pp., 5 by 7-in., Price $3.95.

About a thousand "working words" used in British film and television studios are defined in this attractive little glossary. The words vary from the highly technical to slang or colloquial terms. Intended to make "studio talk" intelligible to the "newcomer or visitor to studios; to people who sponsor films or have some other reason to take an interest in their production, and . . . to amateurs who aspire to 'proper' professional usage," the terms are defined in an informal, explanatory manner with occasional touches of British wit. For example, the definition of *jingle:* "One of those rather dreadful little lines chanted in close harmony, with which so many TV 'commercials' end."

The American reader will find that the more technical words and phrases tend to have identical meanings on both sides of the Atlantic, but he may be amazed and amused by some of the more colloquial expressions. For example, *chippy:* "A carpenter. One such must, as a rule, stand by on the Floor to make minor and sudden variations to the Set which Shooting may demand," and *tea breaks:* "Irritating disruptions of work which occur at least twice every day. Other countries manage without anything corresponding to them, but in Britain they are even the subject of trade union stipulations and clauses in Agreements." Other such colloquialisms call to mind the familiar Wilde witticism "Americans and British have everything in common except language."

It may also be noted that the SMPTE is the only American organization described in the book. It is mentioned twice (pp. 119 and 157). Delightful to read for its witticisms as well as for the information presented, the book is, of course primarily intended as a practical reference, and as such it admirably fulfills its purpose.

Photographic Lens Manual and Directory by C. B. Neblette is a well written little volume (112 pp.) which presents in clear and simple language basic information on camera lenses. Numerous diagrams are included. Probably of the most interest to the intelligent amateur photographer, it would also be useful to the professional photographer working in portraiture, spot news, or other branches of the art. Chapter subjects include Lens Development, Design and General Characteristics; Choice and Testing of Photographic Lenses; and General Properties of Lenses and Optical Tables. A chapter by Allen E. Murray is on Performance of Photographic Lenses. A Directory of manufacturers is included. The author is Professor of Photography at Rochester Institute of Technology, The book is published by Morgan & Morgan Inc., Publishers, 101 Park Ave., New York 17. A paper bound edition is priced at $1.95. The hard bound edition is priced at $3.50.

The McGraw-Hill Encyclopedia of Science and Technology (15 volumes; 8500 pages of text; 600 index pages; 9700 illustrations) was five years in preparation at a cost to the publisher, McGraw-Hill Book Co., 330 W. 42 St., New York 36, of almost $2 million. The 15-volume set is priced at $175. Articles written by more than 2000 authorities cover various fields of Life Science, Physical Science, Earth Science and Engineering, including major applications. Among the articles of special interest are a 14,000-word survey of photography contributed by Walter Clark, who is head of the applied photography division of Kodak Research Laboratories; "Deep-Sea Photography," by H. E. Edgerton; "Acoustics," by Leo Beranek; "Magnetic Recording," by H. F. Olson; and "Space Engineering," by Krafft





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A. Ehricke. According to the announcement released by the publishers, "The names of the contributors read like a 'Who's Who' of the world's scientific community."

BBC Engineering Monograph No. 32, A New Survey of the BBC Experimental Colour Transmissions, issued October 1960, is, in some respects a sequel to Monograph 18, The BBC Colour Television Tests: An Appraisel of Results, issued May, 1958. The current monograph opens with a brief historical account of early experiments in color television. The experimental program transmissions from Alexandra Palace which were carried on between October 1957 and April 1958 are described in detail and the results are evaluated. Experimental transmissions from October 1958 to the present are described. The monograph is available from BBC Publications, 35 Marylebone High Street, London, W.1.

The A.B.C.'s of Camera Repair, by Samuel L. Love, is a glossary of terms for photo technology published in 1959 by the National Camera Repair School. Planned as a study aid for students in the school, it has also been found useful by professional photographers as a convenient reference. Words and descriptive terms from many fields — mechanics, electronics, chemistry, and others — are included when relating to photography or camera repair. "Motion, Newton's laws of" is defined in a brief paragraph, and almost a page is devoted to definitions of various types of files, "coarse-cut," "curved tooth," etc. The book contains 84 pages with definitions ranging from "a-c: alternating current" to "zoetrope: an early motion-picture-viewing device; while only a toy, it is used to demonstrate the principle of vision on which the motion picture is based."

The LaPine Apparatus Review No. 12, 1960, a 16-page brochure issued by Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago, carries an announcement that Tenso-Lab, Inc., Irvington-on-Hudson, N.Y., is now a subsidiary of the company. Also announced is the distributorship of Coleman Instruments. A number of new laboratory instruments are described, including spectrophotometers, pH meters, electrobalances, recorders and related equipment. The brochure is available without charge upon request to the company.

Precision Optics, both custom-made and mass-produced, are described in a brochure, available without charge from Plummer and Kershaw, East Greenville, Pa. The company also offers design and engineering services.

Spectrum of Capabilities is a 20-page illustrated brochure, available upon request from Servo Corp. of America, 111 New South Rd., Hicksville, L.I., N.Y. The brochure describes the company's research and development activities resulting in products used in missile and space systems, simulation systems, control systems, automatic weather stations, data link systems and similar applications.

The 1960 Optical Industry Directory published by the Optical Publishing Co., Box 1753, Lenox, Mass., has been considerably revised and enlarged, and its scope expanded over that of the 1959 issue. Photographic, photoelectric and infrared are covered in more detail as well as advances in instrumentation of space technology. About 400 items are listed under such categories as instruments, components, raw materials and services. Current information on about 1200 American companies supplying these items, and a catalog of corrected lenses, both domestic and foreign, are included. The Directory is priced at $7.50.

A 20-page study describing a system by which educational TV programs can be brought to most schools and homes in Western North Carolina is available without charge from Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N.Y. The system is designed to rebroadcast the programs of WUNC-TV, the educational TV station of the University of North Carolina. A basic unit of this system is the translator, which is a rebroadcast transmitter that receives signals from a broadcasting station and retransmits it without loss of quality to receivers that are out of range of the originating station.

Educators . . .



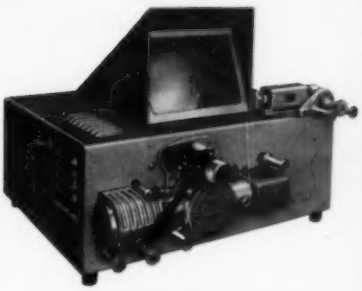
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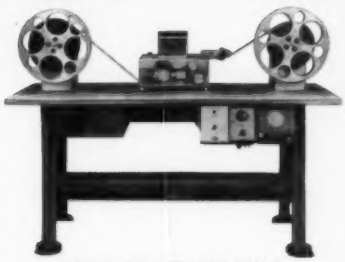


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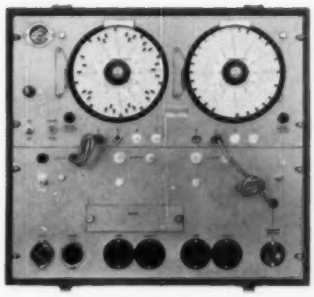
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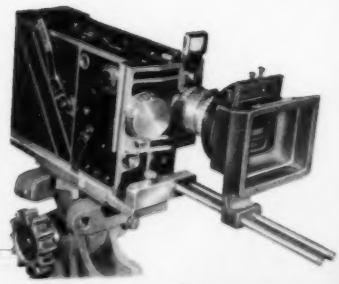
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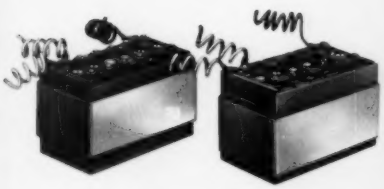
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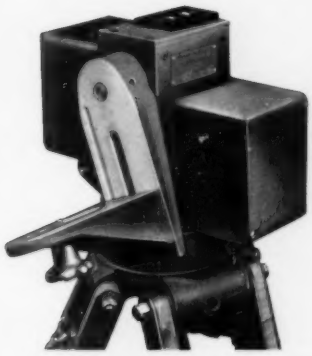
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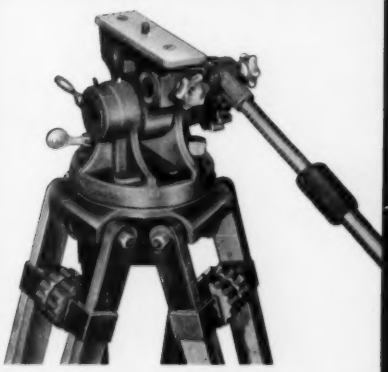
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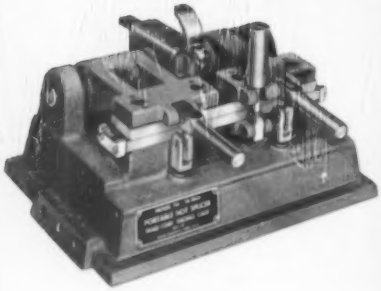
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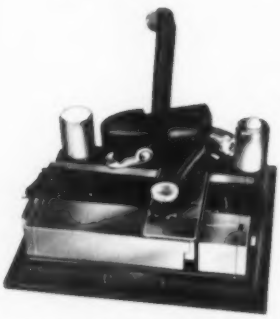


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Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin*.

The subject areas are grouped below:

High-Speed Photograph and Instrumentation
Sound Recording and Reproduction
Television

HIGH SPEED PHOTOGRAPHY AND INSTRUMENTATION

Slow, High Speed Motion Pictures by Means of Spark Flashes: Camera With 50,000 up to 140,000 Pictures/Sec. Maximum

An apparatus has been constructed for high-speed cinematography on continuously moving film with a stroboscopic flashlamp as the light source. The speed of shooting is controlled within a range of 16 to 50,000-140,000 frames/sec. The choice of the gas in the lamp (70% argon plus 30% hydrogen) ensures a flash with a time of less than 1 μsec. The control system synchronizes the flashes with the moments of passing of the perforated openings and switches off the circuit if the temperature in the lamp exceeds a given value. Sample shots from films so obtained are reproduced. (S. C. G.)—[Translated from *Referativnyi Zhur., Fiz.*] F. Frungel. *Explosivstoffe*, *6*:263–64, 1958.

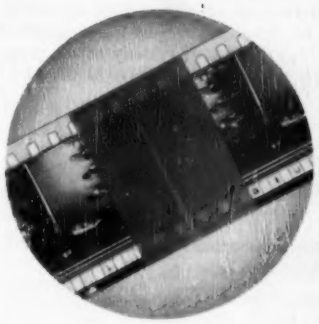
The Distortion of the Tooth of a Film Sprocket on Milling with a Hobbing Cutter

It is very important to know the magnitude of the distortion of the profile of a sprocket tooth, since this affects the uniformity of the release of the film from the tooth. A formula is deduced for determining the magnitude of the distortion of the profile of the tooth, and curves are constructed showing its relation to the number of grooves of a single-cut hobbing cutter. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] S. M. Pertsev. *Inf.-tedkh. Byul. TsKB Min. Kultur. S.S.S.R.*, pp. 30–2, No. 4 (18), 1958.

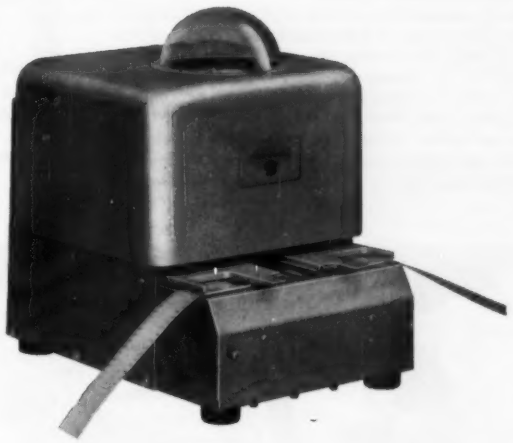
Some Methods of Synchronization in High-Speed Cinematography (from Experimental Work With the FP-22 Camera)

The Soviet-made FP-22 high-speed motion-picture camera is provided with a synchronizing device, but cases arise which require a supplementary device. Three such cases are described. The first of these was the impact of a loaded rod on a glass block. The second was a study of the deformation of drops of molten metal striking a glass surface in a metallization process. The third case was a study of cavitation erosion of solid bodies in an ultrasonic field. (S. C. G.)—S. R. Zhukovskii. *Zhur. Nauch. i Priklad. Fotografii i Kinematografii*, *5*:48–53, No. 1, Jan.-Feb., 1960 (in Russian).

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The Accuracy of Measurements Carried Out by the Methods of High-Speed Cinematography

A mathematical analysis is made of the accuracy of measurement of the speed of a moving body by two methods of high-speed cinematography: by scanning and by framewise exposure. (S. C. G.)—E. A. Tarantov. *Zhur. Nauch. i Priklad. Fotografie i Kinematografii*, *5*:44–7, No. 1, Jan.-Feb., 1960 (in Russian).

High-Velocity Cinematographic Camera FP22

"... The universal multi-objective camera with a single common entrance pupil permits the taking of motion pictures with subsequent projection for exposure frequencies from 5000 to 100,000 frames/sec. ... The camera assembly comprises: illuminating devices, a frequency meter, developing apparatus, and the cinematographic projector ..." *Instruments and Experimental Techniques* (transl. ed. of *Pribory i Tekh. Eksper.*), p. 508, No. 3, May-June, 1959.

Use of High-Speed Cinematography for the Study of Processes Occurring in Liquids Under the Action of Ultrasonics (in Russian), S. R. Zhukovskiĭ, V. F. Kazantsev and L. O. Makarov, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii*, *5:* 133–140, No. 2, Mar.–Apr. 1960.

Descriptions are given of the experimental arrangements used in making high-speed motion-picture films of ultrasonic phenomena studied at the Acoustics Institute of the Academy of Sciences of the U.S.S.R. They included the destruction of a film of dirt on a glass surface and ultrasonic drilling, with their related phenomena of cavitation, erosion and bubble formation. A wide range of frame frequencies (750–50,000 frames/sec) was used, enabling the processes to be studied both as a whole and in detail. Frame-by-frame analysis allowed a quantitative study of the processes to be made and curves to be drawn.—S. C. G.

SOUND RECORDING AND REPRODUCTION

Standard Specifications for Photographic Sound Tracks

Departmental Standard, Norm-Kino 4–59, *35mm. Motion-Picture film, Dimensions and Positions of the Sound Track on Negative Records and Film Copies*, from the Ministry of Culture of the Soviet Union is reproduced and commented upon. (S. C. G.)—*Kino-Mekhanik*, pp. 31–2, Dec., 1959 (in Russian).

Problems of the Perception of the Stereophonic Effect With a Multichannel System of Sound Reproduction

V. S. Man'kovskiĭ. *Trudy Leningrad. Inst. Kinoinzhener.*, pp. 52–61, No. 5, 1959 (in Russian).

Magnitude of the Photocurrent in the Photocell Circuit in the Absence of a Sound Track.

B. N. Ukhin. *Trudy Leningrad Inst. Kinoinzhener.*, pp. 15–20, No. 5, 1959 (in Russian).

Type 3 Magnetic Tape

Methods of manufacture have been worked out for [Soviet-made?] Type 3 magnetic tape on acetate base. The relations between the electroacoustic properties of the tape and the composition and conditions of manufacture of the ferro-lacquer, and also the magnetic orientation of the powder in the ferro-layer have been ascertained. The electroacoustic properties of the laboratory samples have been compared with those of the best foreign magnetic tapes. The first batch of experimental tape has been tested. It was found that the electroacoustic properties of Type 3 magnetic tape are better than those of Type 2 and hence Type 3 reaches the same level as one of the best foreign tapes. (S. C. G.)—[Translated from *Tekh. Kino i Televideniya*] M. S. Chel'tsova. *Trudy Vsesoyuz. Nauch.-Issled. Inst. Zvukozapisi*, pp. 73–87, No. 6, 1959.

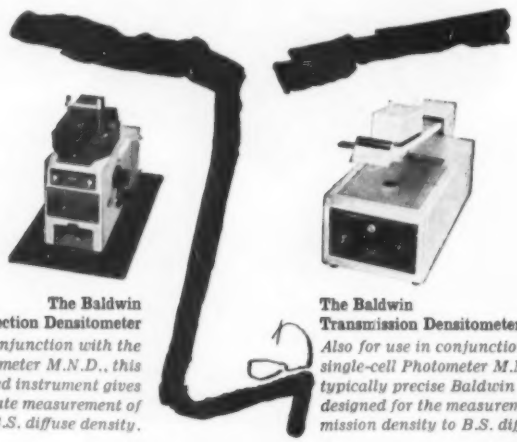
TELEVISION

A System of Television Projection and Kinescope Recording with Optical Doubling of the Scanning Raster

A survey is made of the systems at present in use for television projection and kinescope recording, and their deficiencies are pointed out. A new system is described in which the image on the tube is reflected by two systems of horizontal mirrors to form two separate images, one above the other. A synchronized shutter cuts out each reflected image alternately, and film-transport speed is adjusted so that, for a 25-frames/sec TV standard, the two fields are imaged on the same film frame. The machine, which has been made by the Leningrad Electrotechnical Institute of Communications, is used both for television projection and kinescope recording. (S. C. G.)—A. A. Gol'din and D. A. Taranets. *Tekh. Kino i Televideniya*, pp. 25–33, Nov., 1959 (in Russian).

Practical Problems in the Construction of Stereo Television Systems

The principles of construction of two-channel and single-channel systems of spatial television and factors influencing the stereo effect are discussed. An account is given of the optical systems of stereo television apparatus. The possibility of transmitting stereo-pair images with standard frequency bands is discussed. (S. C. G.)—[Translation of Authors' Abstract] P. V. Shmakov and V. E. Dzhakoniya. *Tekh. Kino i Televideniya*, *4*:11–21, March, 1960 (in Russian).



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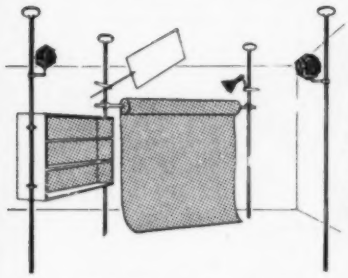
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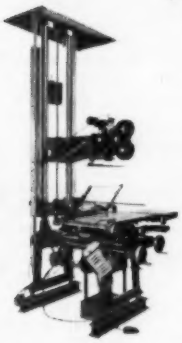
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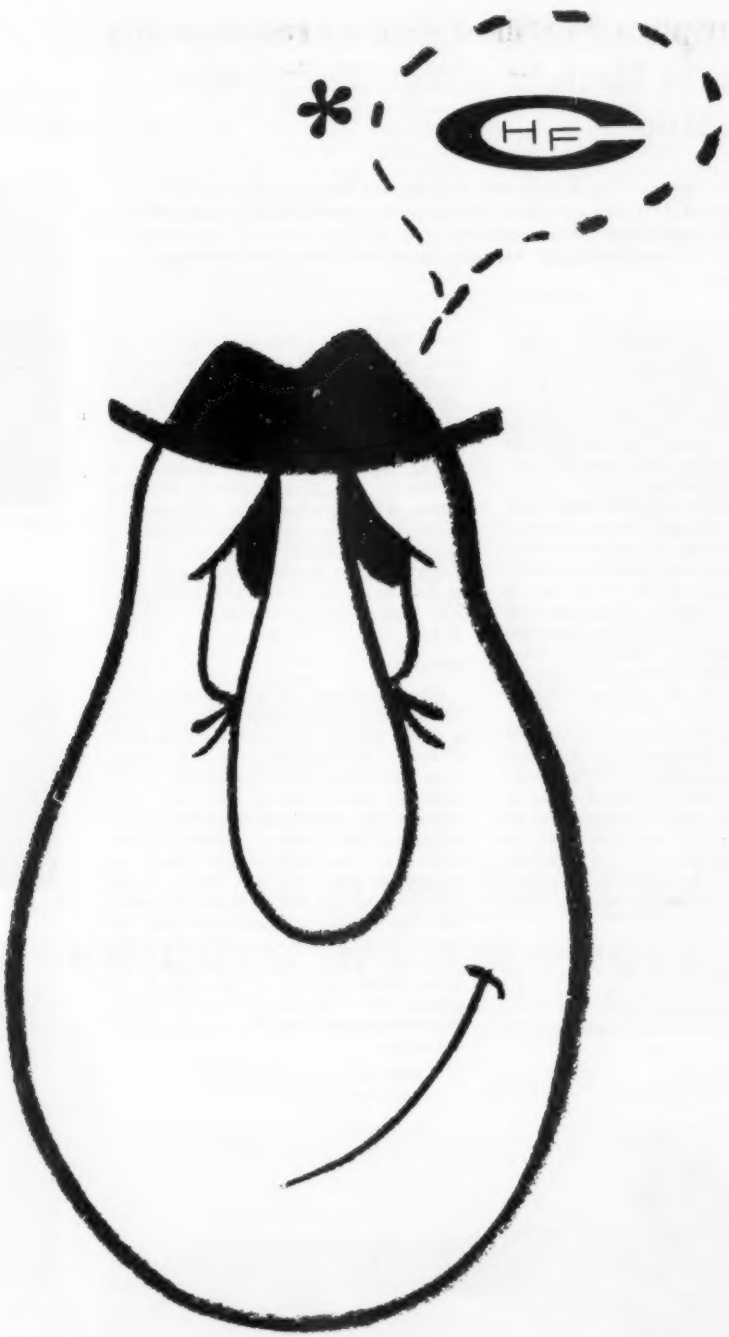
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Intermix Splicing of Triacetate to Polyester Base Film by Means of a High Temperature Adhesive Strip

By LEONARD A. HERZIG

A method for intermix splicing of triacetate to polyester base film is described, using the process of heat and pressure, and applying automatically a strip of reinforcing high-temperature thermal-setting tape to both sides of the film. This method may be used for all types of safety base film. The splice is stronger than the film itself.

Film splicing has presented a serious problem for many years in both the microfilm and motion-picture fields. To date, Prestoseal's various models of the "Presto Splicer" have been capable of handling buttweld splicing of triacetate to triacetate or acetate film, and the splicing of polyester base to polyester base film.

Today's problems, however, differ considerably as it becomes more apparent that the intermixing of triacetate base film with polyester base film is imminent. The only means available is the use of pressure-sensitive tapes. After studying these problems, it was obvious that other solutions for splicing intermixed bases were required which would not have the difficulties inherent to pressure-sensitive tapes.

During a period of five years, Prestoseal has tested many high-temperature thermal-setting adhesives in its Research Laboratory and finally has chosen one which could be coated on Mylar, was compatible to all present types of base materials (such as triacetate, acetate and polyester), and by its application as a bonding strip made the splice the strongest part of the film.

Presented on May 4, 1960, at the Society's Convention in Los Angeles, by Leonard A. Herzig, Prestoseal Manufacturing Corp., 37-27 33rd St., Long Island City 1, N.Y.
(This paper was received on September 14, 1960.)

Once the material became available, the need for a precise apparatus to position accurately this bonding strip of reinforcing material had to be designed and built. The new "Hercules Model" of the Presto Splicer fulfills this requirement.

The "Hercules Model" is an improved version of the Miracle Model buttweld splicer, with an adapter for automatically precutting a sliver to be used for splicing of dissimilar materials. It allows the sliver material to be positioned on both sides of the film or on one side of the film only. The total time for completing a splice is 15 sec.

Operation

Figure 1 shows the sliver being pulled through the sliver clamps. After the sliver is pulled through the third and final sliver clamp, it is automatically cut to length.

In Fig. 2 the sliver clamps have automatically been released after the sliver was cut. By centrifugal force half of the clamp has folded into an upright position while the other half of the clamp has positioned itself on the heater block. After having cut the film to be spliced, the film clamps are positioned over the heater block. This automatically folds the silver holder still further until the sliver covers the top of the film to be spliced. The film is now sandwiched in between one sliver that is wrapped around both sides.



Figure 1

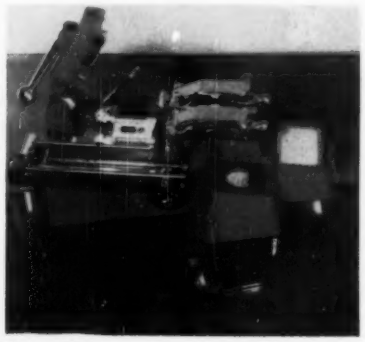


Figure 2



Figure 3

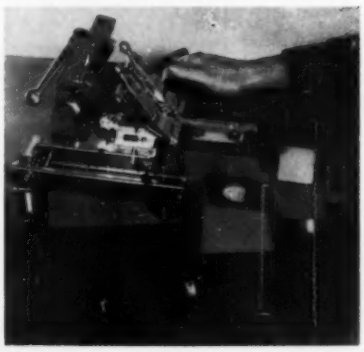


Figure 4

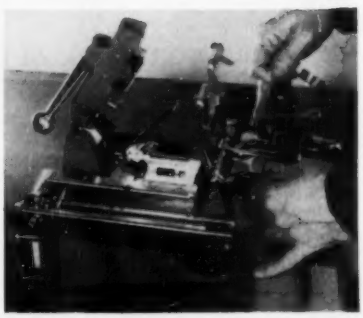


Figure 5

Figure 3 shows the pressure being applied at the same time the machine is placed through the heat cycle.

In Fig. 4 the splice has been completed after the pressure has been released, and the clamps are being repositioned to the forward unclamp position.

Figure 5 shows the film as it is removed from the clamps, with the bonding strip fastened to the film. Its surplus will be trimmed off with an external trimmer (not shown).

Performance

The sliver material is 0.003 in. thick and 0.100 in. wide and is packaged in a cartridge and mounted on the back of the splicer. The cartridge contains four 225-ft rolls of material. When a new spool of sliver material is required, it can be threaded automatically in a matter of seconds.

The application of a sliver 0.003 in. thick by 0.100 in. wide to both sides of 0.006 in. film would normally make a total thickness of 0.012 in. However because of the application of heat and pressure, the sliver is compressed into the film and results in a total thickness, including the film, of 0.011 in. or less. Film that is bonded by this method has recently been tested on a Scott Tensile Tester, and at no time has ever let go. In all cases the film itself has either broken, or stretched before breaking, at other than the spliced area.

This type of bonded splice lends itself uniquely to the Recordak "Lodestar" reader, where a Mylar leader stock needs to be fastened to an acetate or Cronar base film, and the splice must be capable of withstanding winding and rewinding shocks. When trimming the surplus material from the splice, the trimmer undercuts the film slightly to prevent any material interfering with the film while it is in motion.

When similar bases are spliced together the reinforcing strip need not be used, although there are times when reinforcing the standard splice becomes a requirement. In these instances a sliver on one surface only need be applied. This allows the base of the film to be fused together with a sliver to act as a reinforcing bonding agent.

Advantages

The reason for using two slivers on dissimilar bases (one on each side) of the material to be spliced is that the base materials do not fuse together as they are not compatible. Therefore, in reinforcing both sides of the film with a bonding strip, there is no tendency for the film to collapse as would be indicated where just one sliver was used. This does not occur, however, when using similar base materials for the following reasons:

(1) The base materials bond to each other, creating a homogeneous splice.

(2) The sliver reinforces this bond with its own bond, adding to its strength.

The splice is so strong that when the spliced section of the film to the leader stock comes out of the dryer, the splice cannot be torn and must be broken off on both sides of the splice. Other advantages of this splice in the darkroom are that no runoff of developer or hypo occurs from liquid being trapped, as previously occurred where staples, rivets, etc., were used; and the splice will not tear or injure squeegees when they are used in processing equipment.

Application

The following is a list of some of the fields to which the application of this reinforced splice lends itself:

(*1*) *Microfilm:* Lodestar Reader, darkroom processing, and permanent records—negatives and prints.

(*2*) *Motion Pictures:* reclaiming of raw stock, processing, continuous printing, lip synchronization, and release prints.

(*3*) *Magnetic Tape:* sound recording, instrumentation (information retrieval), computer, reclaiming materials, and video tape.

(*4*) *Punched Paper Tape:* automatic printing, instrumentation, and computer.

Acknowledgment

The cooperation of E. I. du Pont de Nemours & Co. is gratefully acknowledged, and the many valuable suggestions of Edward Rosse.

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CONTROL TECHNIQUES IN FILM PROCESSING

Prepared by a Special Subcommittee of the Laboratory Practice Committee of the Society of Motion Picture and Television Engineers

WALTER I. KISNER
Subcommittee Chairman

Foreword by **E. H. REICHARD**
Chairman, Laboratory Practice Committee



CHAPTERS

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2. General Principles
3. General Aspects of Motion-Picture Film Processing
4. Mechanical Evaluation and Control
5. Instruments for Photographic Control
6. Control Strips and Sensitometric Curves
7. Sensitometric Control of a Standardized Process
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9. Chemical Analysis and Control
10. Economic Considerations in Establishing a Process Control System

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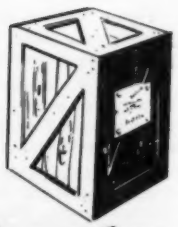
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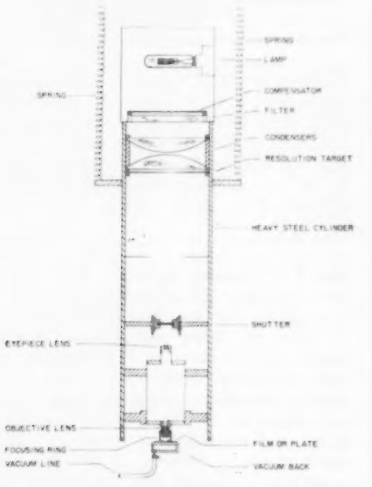
Shop and Mail Early belongs now to the ages, along with What Hath God Wrought, and other great messages expressing human emotion and concern as some awe-inspiring event signals the turning of another page of the recorded history of mankind. This message, sent by Postmaster General Arthur E. Summerfield, marks the beginning of the satellite era of communications. The historic letter was first sent by wire line from Washington, D.C., to Stump Neck, Md., where the Naval Research Laboratories are located. It was then beamed by microwave at the Echo Satellite orbiting 1000 miles above Earth. The signal was "bounced" off the passive reflector and picked up by a sensitive tracking antenna at the Holmdel, N.J., station of the Bell Telephone Laboratories to the Postmaster's office in Newark, N.J., where it was converted to its original form by a facsimile receiver. The test was managed for the Post Office Department by Adler Electronics Inc., New Rochelle, N.Y.

While the transmission between Washington and Newark was instantaneous, approximately five minutes were required from the time the letter was fed into the facsimile transmitter at Washington until it was reprinted by the facsimile receiver at Newark. With existing techniques, however, the system is capable of simultaneously transmitting up to 50 letters in a three-minute period. Satellite links capable of transmitting television signals are planned for the near future.

The 500-lb Courier, at this writing the United State's newest communication satellite, was built by Philco Corp. at its Western Development Laboratories, Palo Alto, Calif., for the Department of Defense. This satellite is not designed for navigation purposes or scientific measurements nor is it "out there" on a reconnaissance patrol. The Courier is, as its name implies, a means of carrying messages from one ground station to another. It has an estimated capacity of close to 3½ million words a day. Ground complexes were provided by the International Telephone and Telegraph Company's ITT Laboratories at Nutley, N.J., while tracking antennas were provided by Radiation, Inc., Melbourne, Fla.

The Courier completes its orbit around Earth in about 110 minutes at an altitude of 600 miles. It is in view of each ground station for varying periods up to 15 minutes. During the time it is in view it will accept messages from one ground station and, on command, deliver them to another. At present, command and data stations are located at the Army Signal Research and Development Laboratory's Astro-Observation Center, near Fort Monmouth, N.J., and at the Army Caribbean Signal Agency's Space Communications Center, near Ponce, Puerto Rico. The Courier contains a command decoder used to control its operation and to monitor the performance of its instruments. It is powered by the rays of the Sun. A solar outer shell consisting of some 20,000 individual solar cells wired together provides 62 w of power.

Plans to put the first station of a satellite relay system into space within a year have been announced by American Telephone and Telegraph Co. The station would provide for the experimental transmission of telephone calls, television, data transmission and other types of communication between the United States, the United Kingdom and continental Europe. The proposal has been presented to the FCC. The system would make use of solar-powered satellites orbiting at an altitude of about 2200 miles. Electronic amplifiers aboard the space stations would catch signals from Earth, immediately boost and relay them on to ground stations in the United States, Great Britain and Europe. The proposed spheres would be 4 ft in diameter and weigh about 175 lb. About 60% of the surface would be covered by glass-coated solar cells. A metal skin and two slotted antennas would comprise the rest of the surface. The plans call for installation of the initial U.S. ground station at the Bell Telephone Laboratories' installation at Holmdel, N.J., where current Bell System space communications work is going on.



A camera capable of projecting a parallel line pattern of 50,000 lines/in. is being used by the National Bureau of Standards in a research project directed toward the development of a standard method for determining the resolving power of photographic materials. Five laboratories in the United States and Canada are working toward this goal which has been set by a committee of the American Standards Association. The camera, designed by C. S. McCamy of the Bureau's photographic research laboratory, was used in an experiment during which a photocopy of the first page of the Bible was made at a linear reduction rate of 1000, thus reducing the area by a total factor of one million. The page was first reduced 2.5 times to fit into the camera's chart holder, then it was reduced by a factor of 400. The printing was legible when viewed directly at a magnification of 1250x.

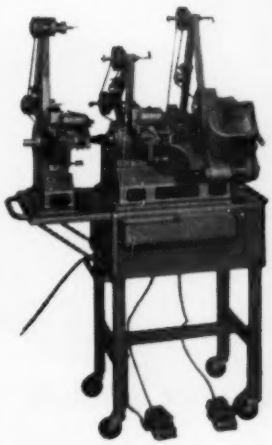
The camera's optical system is essentially a fine apochromatic microscope system operated in reverse to make an extremely small image of a large chart. Film or plates to be tested are placed against a surface attached to the objective lens mount and a gear mechanism permits a minute adjustment of focus. The camera is operated at a constant temperature to avoid changes in focus resulting from thermal expansion or contraction.

Xeroradiography, a process for developing industrial x-ray pictures in 15 sec, was shown for the first time by Rank-XeroX Ltd. at the Industrial Photographic and Television Exhibition held in London, November 21–25. At the same time, the Cine and Photographic Division of Rank Precision Industries Ltd. introduced the Xenon Lantern for use with the Bell & Howell Model 609 16mm cine projector. The lantern is designed to give constant steady light to the screen and features pushbutton control for automatic and instantaneous starting with no warmup required. Among other exhibits was the Bell & Howell Model 173 BD 16 mm time and motion study projector. A hand crank is used to advance a single frame at a time with a counter to register up to 100,000 frames.



A portable field collimator for checking long-range lenses and cameras has been developed by Zoomar, Inc., Glen Cove, N.Y. The instrument measures 10 in. in height; 6¼ in. in width; 30 in. in length; and weighs 25 lb. The design is based on the premise that a collimator objective need not have a focal length longer than the lenses tested if it is corrected over a considerable extra-paraxial field and can even be shorter if its resolving power is extremely high. The designers also considered it unnecessary to cover the entire area of the lens under test. For most measurements, such as the focal plane position, chromatic aberrations, etc., the theory was advanced that it could be advantageous to examine portions of the lens successively when checking for symmetry and possible cylindrical conditions.

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The Model 339 Sweeping-Image Camera announced by Beckman & Whitley, San Carlos, Calif., is reported to produce an uninterrupted streak image 50 in. long on 35mm film. Designed to be in recording condition during operation, it can be used for the documentation of randomly occurring events which are not suitable for synchronization with the instrumentation. The writing rate is reported at 9mm per μsec at a maximum mirror speed of 2600 rps. The time resolution is 5×10^{-9} sec and the minimum writing time is 145 μsec. Features not included in previous models include a beryllium rotating mirror, essentially distortion free at operating speeds; an all-mirror, axially aligned relay optical system to permit operation in the high ultraviolet region; a newly developed film track configuration to give a flat film plane and optimum assessment curve and a transistorized automatic turbine-speed monitor to provide an overspeed safety cutout. The camera may be operated in various positions. Other features include 100-ft daylight film loading and arrangements to permit operation as a synchronized streak camera where required.



A 19-lb closed-circuit TV camera. Model 700, designed especially for simplicity of installation and portability has been announced by Tele-Tronics Corp., 12786 Western Ave., Garden Grove, Calif. The power input is 117 v (± 7v), 60-c, a-c, 65-w. Features include 8.0-mc video amplifiers to provide 600-line horizontal resolution; internal synchronizing signal generator to provide 2:1 scanning line interlace for 350-line vertical resolution; and transmission line aperture-corrector circuitry. A general purpose *f*/1.9 25mm lens is supplied in a three-lens turret designed to accommodate any 16mm "C" mount lenses. The camera is priced at $1295. A model with built-in microphone and amplifier sound channel, the 700-S, is priced at $1495.

A compact television sound control desk designed by Marconi Wireless Telegraph Co. for one-man operation is being manufactured in three models designated Major, Medium and Minor. The Major handles 26 microphone inputs and has 54 amplifiers; the Medium, 18 microphone inputs, 41 amplifiers; and the Minor, 11 microphone inputs, 23 amplifiers. In the Major version the distance between the outermost fades is 4 ft, 10 in. The overall height is 3 ft, 6 in. A number of the desks have been installed by various program contractors to Britain's Independent Television Authority.

Glass-base receiving tubes designed for economy and simplicity of installation have been developed by the RCA Electron Tube Division, Harrison, N.J., and are expected to be in production in 1961. The new tube, called Novar, has a pin-circle diameter of 0.687 in. and a pin length of 0.350 in. Internal leads have a diameter of 30 mils. There is a distance of 0.212 in. between the pins. This spacing is calculated so that the tubes may withstand high voltage gradients between pins and be less susceptible to breakdown at high voltages than tubes having closer pin spacings.

The F/4 Zoomar Reflector is a 20-in lens developed by Zoomar, Inc., Glen Cove, N.Y. The new lens is adaptable to all types of 16mm and 35mm motion-picture and TV cameras. It is designed for high resolution, compactness and light weight. The distance from the front to the film plane is 14 in. outside diameter, 6¼ in., and the weight is about 7 lb. The closest focusing distance is 500 ft. The resolution in Kodak Plus X film is 50 lines/mm. All lens elements are antireflection coated. It is priced at $1500. A filter frame or filter wheel is available as optional equipment. Other accessories are available.

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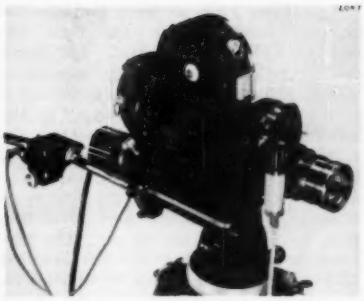
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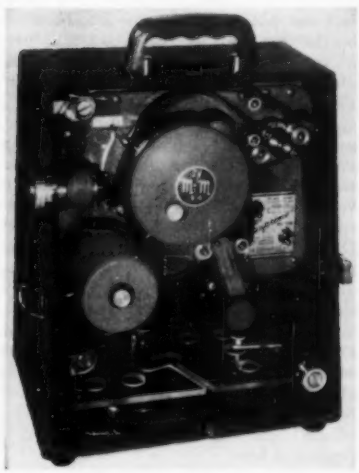
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A new motor drive for the zoom movement of the 17–70 Angenieux varifocal lens has been announced by Arriflex Corp. of America, 257 Park Avenue South, New York 10. A miniature motor and gear mechanism is mounted directly on the lens barrel by means of a special split-ring clamp. The control unit is designed to mount on the panhead handle. The motor operates from the same 8-v d-c battery pack as the camera. The motor drive is priced at $249.50



The Movie Mate is an automatic 16mm sound projector with a built-in transparent continuous projection magazine and holding an endless loop of up to 400 ft of 16mm film. It is produced by Harwald Co., 1245 Chicago Ave., Evanston, Ill. The unit weighs about 23 lb and occupies about one cubic foot of space. It is recommended by the manufacturer for sales presentations, schools or other educational and industrial uses. The projector runs on almost any type of house current, 25 to 60 cycle, 105- to 125-v a-c or on d-c. It is priced at $498.

New home movie equipment has been announced by Bell & Howell, 7100 McCormick Rd., Chicago 45. The 8mm camera, the 314, is designed for the movie maker who wants completely automatic operation; it has one speed and a universal focus lens. Features include an 11-element *f*/1.8 Comar zoom lens and coupled viewfinder. It is priced at $169.95.

The projector, called the Dual/Lectric is designed for completely automatic operation. Features include remote control (Roto-Remote) which permits the operator to start, stop or reverse the film from any location within the room. Price range is from about $239.95 to $264.95, depending on the type of lens.



The Moviematic Jr., a product of Technical Service Inc., Farmington, Mich., is a compact repeater projector designed to show 8mm silent film in normal light. The Kodak-built mechanism permits continuous showing of a 5-min film, or the film can be switched on and off for each showing. The film ends are spliced together to avoid threading and rewinding. The projector is priced at $98.50.

A barndoor that folds flat to fit in a jacket pocket is designed for professional lighting control with reflector bulbs. Introduced by Lowel-Light Photo Engineering, 421 W. 54 St., New York 19, it is used with the Lowel-Light clamp-on lighting unit and with other portable clamp-on lights using R 40 type reflector bulbs, 150 to 500 w. Made of flexible aluminum, the device weighs 4½ oz. The 5 by 10-in. door flaps are removable and replaceable. The unit is priced at $5.75.

A color motion-picture film for use in high-speed cameras with exposures as short as 1/50,000 sec has been announced by Eastman Kodak Co., Rochester 4, N.Y. The film, exhibited at the Fifth International Congress on High-Speed Photography, was the subject of a paper presented at the Equipment Papers and Demonstrations Session by A. Earl Quinn. The film has a tungsten light speed of 125. It can be used interchangeably with Kodak Tri-X black-and-white reversal film.

The Model R-BW Modulator and Light Source for Depue-Carlson Step Printer, equipped with 1000-w adjustable lamphouse, has been announced by Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N.Y. The optical system is designed to provide uniform light on the 35mm aperture of the Depue-Carlson Transport. A cold mirror of the effective interference type and a heat absorber are used so that very little heat can reach the printing aperture. Modulation of the light is achieved by mean of five a-c solenoid-

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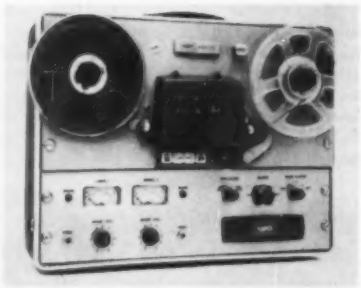
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The lamphouse is designed for a 1000-w T-12 bulb with blower. Bulb alignment is made in darkness by adjusting three knobs providing for vertical, transverse and rotational motion of the bulb. A damping cylinder is incorporated to prevent mechanical shock to the lamp filament during opening and closing. The unit is adaptable to automatic control using punched tape or modified drop board. Dimensions are 20 by 20 by 10 in.; weight is 70 lb. It is priced at $3000.

The Vega-Mike is a wireless microphone which weighs 7½ oz, measures 5 in. in length and 1 in. in diameter. A product of Vega Electronics Corp., 10781 N. Highway 9, Cupertino, Calif., it is designed as a self-contained miniature FM broadcast station, including transistors and battery. The neck strap is part of the system, acting as an antenna element. The power output of the microphone is no more than 20 thousandths of a watt, but it is said to have a useful range of up to a half-mile or more. Operating frequencies range from 25 to 45 mc. The microphone has been field tested in various situations including use by the American Broadcasting Company at the national political conventions. It is priced at $249.75. An FM receiver designed for use with the microphone is priced at $267.75. When purchased together as a system the combination is priced at $495.



Professional tape recorders announced by Ampex Professional Products Co., Redwood City, Calif., are part of the new PR-10 series of recorders, mixers and speaker-amplifiers designed for compactness and economy. The series includes a monophonic recorder priced at $895, and a combination stereophonic/monophonic recorder priced at $995. These prices apply to the portable versions of the machines. The recorder is also available as a rack unit 14 in. high. Both units are two-speed and available at 7½ – 15 in./sec, or 3¾ – 7½ in./sec. Among features and accessories available are 4-position head assembly, 4-track stereo playback, new compact electronics, automatic threading and remote control.

The TapeEditor, an electronic video tape editing machine, is a product of Telescript CSP Inc., 155 W. 72 St., New York. The machine is transistorized and consists of two units, the tape viewing unit and the edit pulse unit. Described as "desk top size," it is priced at about $1200.

The Bolex 18-5, an 8mm projector for showing home movies, has been announced by Paillard, Inc., 100 Sixth Ave., New York 13. Featuring "super-slow motion," the projector is equipped with a switch to drop the speed from 18 to five frames/sec. A variable shutter is incorporated that automatically changes from three to nine blades as the speed drops to five frames/sec. This is for the purpose of eliminating flicker and to protect the film from burning and drying out. The projector is priced at $149.50. The firm has also introduced an 8mm zoom camera, the Bolex Compumatic Super Zoom Camera, featuring the Pan Cinor 40 Zoom lens. The zooming range is from 8 mm wide angle to 40mm telephoto. Another version of the lens, the Pan Cinor 40R is equipped with a built-in split-image range finder. The price range for the camera, equipped with the Pan Cinor 40 begins at $225. Equipped with the Pan Cinor 40R, the price range begins at $295.

A 16mm magnetic-optical sound projector, the Bolex S-221, has been introduced by Paillard Inc., 100 Sixth Ave., New York 13. The projector's overplay feature permits the recording of one track directly over another without erasing. It is also possible to combine a music track on the film with live narration. The projector has a 2000-ft film capacity with pushbutton sprocket guides for ease in threading. Separate threading paths for optical, magnetic and silent films eliminate the need for running the film over unnecessary parts. An illuminated stroboscope is incorporated to show the slightest variation in running speed so that the correct running speed can be maintained. Double-perforated films with a quarter track, single-perforated films with an optical and a 50-mil magnetic track, or single-perforated film with the full 100-mil track can be used without adjustment. Designed especially for industrial and other audio-visual uses, the projector is priced at $1250. Included is an 8-in. speaker built into the machine's removable lid, microphone, earphone and 50mm Hi-Fi projection lens.

The Master Vu-Graph Series 7700 Overhead Projectors has been announced by the Charles Beseler Co., 219 S. 18 St., East Orange, N.J. Designed especially for classroom use, the projector head stands at 17½ in. at maximum height; overall dimensions of the projector housing are 23 by 12½ by 12½ in. The projection stage accepts 10 by 10-in. transparencies.

Brady Quick-Cue Contact Tabs are produced by W. H. Brady Co., 727 West Glendale Ave., Milwaukee 9, Wis. These are highly conductive, pressure-sensitive aluminum foil tabs which are applied to motion-picture film, film strips and magnetic recording tape for automatic cuing operations. When the tab reaches the contact points of a relay on the machine, its purpose is to actuate the mechanism to stop and shut off the reproducer, or reverse and repeat the program. The tabs are made with a special permanent adhesive to stick tight upon contact. The average price is less than 2 cents per tab.





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Manager-Administrator. Presently with large missile manufacturer engaged in missile R&D and production. Present position (6 yrs) as Head of Photographic Dept. engaged in all phases commercial, industrial and scientific photography involving still, motion and graphic arts media. Eleven yrs experience teaching and administering scientific photographic organizations. Successful experience in design and utilization of camera pods and systems for use on ballistic missiles. Age 36, BS and MS degrees, seeking challenging position with organization engaged in R&D and/or production in missile or space vehicle field. Confidential resume on request. Write: MHB, 105 East 30 St., Austin 5, Texas.

Sound Recording Technician. 26 yrs experience recording on tape, disc and film; mixing, dubbing and technical background in recording techniques; understanding and know-how of recording problems. Background in radio, television, recording and motion pictures. Administrative and executive abilities. Member AES and active member SMPTE. Free to travel. Write: Alfred M. Zemlo, 421 Haskell St., Beaver Dam, Wis. TUrner 5-4039.

Cameraman. Extensive cine and still experience in documentary training films, photo-optical instrumentation, high-speed and theatrical production. Also experienced in cutting and all phases of motion-picture laboratory work. Designed and equipped motion picture laboratories for industrial firms. Recently completed overseas assignments in the British West Indies and South America. Will consider any position in photography that will enable me to utilize past experience. Will relocate to any area. For further details write or call: Irwin M. Black, 765 West Calle Lerdo, Tucson, Ariz., AXtel-4-4227.

Motion Picture Lab Manager and Color Process Engineer. Wide film manufacturing plant experience and subsequent field experience in setting up and operating color processing labs in the East and process development. Familiar with quality control procedures, chemical analysis, sensitometry of films, color print timing, color printing, duplicating and related optics. Also practical knowledge of the cinematographic arts and lab-shooting-company relations. Qualified also to set up and manage industrial department of photography. Several patents. College Grad. Desires West-Coast location. Reply Box No. 691, Hollywood, Calif.

Photo Coordinator Motion-Picture Cameraman. Experienced in most phases of instrumentation, data gathering and motion-picture production photography. Married, 29 yrs old, will relocate. Active member of SMPTE. Resume on request. Marvin Atwell McCoy, 3708 N. 23rd St., Arlington 7, Va.

Film Production Coordinator. Five yrs experience planning, budgeting, scheduling and producing motion pictures and audio-visual material; duties included expediting, distributing, laboratory and supplier liaison, editing, client contact, casting, supervising recordings, artists, cameramen and crews, coordinating technical and administrative processes from laboratory through editing to final answer print approval. Seeks position as unit mgr, preferably N.Y. area but willing to relocate. Age 27, married, B.A. Degree in documentary film production. E.K., 210-15 23rd Ave., Apt. 6-J, Bayside, N.Y. BAyside 4-1758.

Positions Available

Writer-Director—Films. Requires creative approach to educational medical scripts aimed at physicians and allied audiences. Both pure educational and product-oriented films are produced and distributed through company library. Challenging and rewarding career opportunity with all the fringe benefits of a leading company. If you have the qualifications required, please send resume which should include film credits and salary desired, to Personnel Dept., Wyeth, Box 8299, Philadelphia 1, Pa.

Laboratory Technician. Opportunity for expert technician with complete all-around knowledge, for motion-picture laboratory equipped for Ansco reversal and Eastman Kodak negative and positive. Salary and bonus, opportunity to invest. Universal Color Studio, 136 West 32 St., New York 1.

Electronic Engineers. Circuits and systems development and design in fields of broadcast and closed-circuit TV, commercial and military. Transistorized circuit experience necessary. Fastest growing company in field. Many benefits. Participation in ownership available. Foto-Video Electronics, Inc., 36 Commerce Rd., Cedar Grove, N. J. CEnter 9-6100.

Cameraman. Experienced 35mm color filmstrip cameraman. Salary open. **Printer for 35mm Color Film.** Experienced on Bell & Howell continuous loop printer or step printer. Salary open. Send resume to W. Jones, 234 West 13 St., New York 11.

Technician. Experienced techician to be assistant to chief engineer. No papers or degrees needed. Must be conversant with both radio and television and willing to supervise and train junior technicians. Contact Conrad Lavigne, CFCL Box 620, Timmins, Ont., Canada.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

Complete file, Vol. I No. 1 through Dec. 1959 with indexes. Fine condition: $500. James G. Barrick, 15726 Fernway Ave., N. W., Cleveland 11, Ohio.

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Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan-Dec. 1950; Jan., Feb., Apr.-Dec. 1951; Jan-Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.-Dec. 1947, 1948–1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

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Compete set of Journals Jan. 1949 to Dec. 1958. Perfect condition. What offers? Write: J. G. Jackson, 210 Kingsway South, Port Alberni, B. C., Canada.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

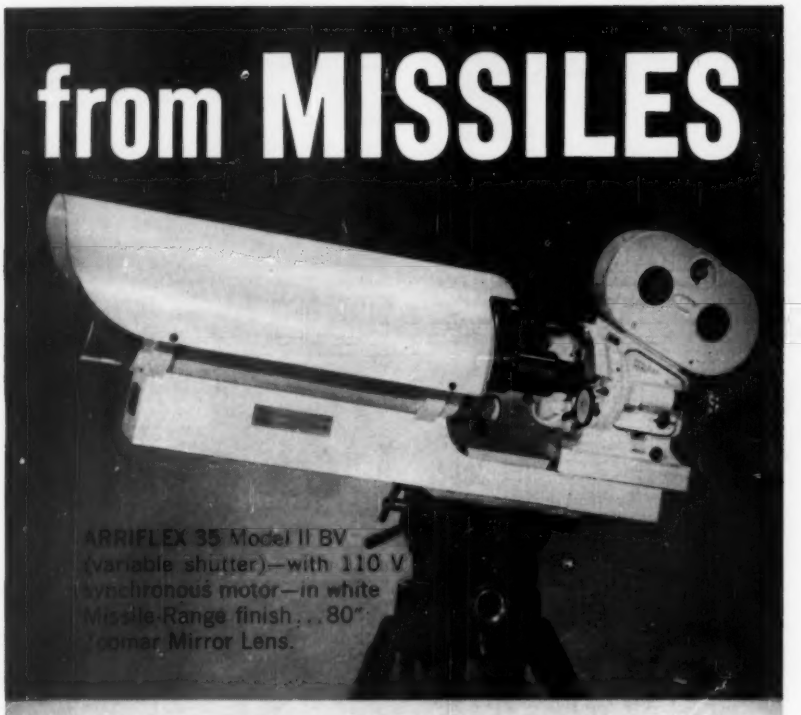
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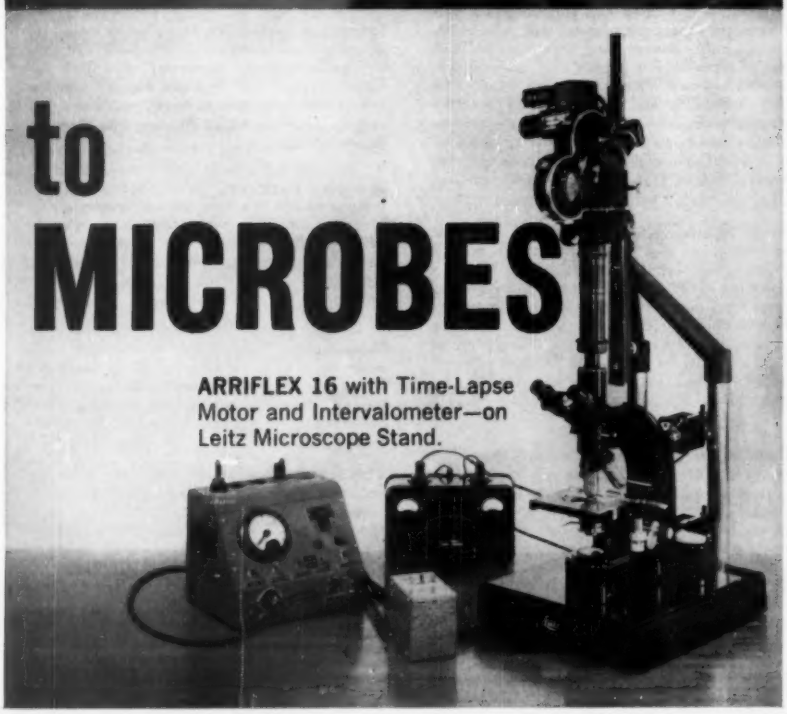
Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Transactions No. 1, 1916 ($5 offered); No. 6, 1918 ($10 offered); No. 7, 1918 ($10 offered). James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

Mar. 1939, May 1940, July, Feb. 1942, July 1949. V. E. Patterson, 2 North 30th St., Phoenix, Ariz.

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Meeting Calendar

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, New York.
Seventh National Symposium on Reliability and Quality Control, ASQC, AIEE, IRE, EIA, Jan. 9–11, 1961, Bellevue-Stratford Hotel, Philadelphia.
ISA, Winter Instrument-Automation Conference and Exhibit, Jan. 16–19, 1961, Sheraton-Jefferson Hotel & Kiel Auditorium, St. Louis, Mo.
American Astronautical Society, Jan. 16–18, 1961, Sheraton Hotel, Dallas, Tex.
ASME, National Aviation Division Conference, Mar. 12–16, 1961, Statler Hotel, Los Angeles.
American Society of Photogrammetry, ASP-American Congress on Surveying and Mapping, Mar. 19–25, 1961, Shoreham Hotel Washington, D.C.
IRE International Convention, Mar. 20–23, 1961, New York Coliseum, New York.
National Microfilm Association, National Convention, Apr. 4–6, 1961, Hotel Sherman, Chicago.
ASTM, Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, Apr. 5–7, 1961, Benjamin Franklin Hotel, Philadelphia.
ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, 1961, Shamrock-Hilton Hotel, Houston, Texas.
DAVI, Apr. 24–28, 1961, Deauville Hotel, Miami Beach, Fla.
ISA, 7th National Aero-Space Instrumentation Symposium, May 1–4, 1961, Fort Worth, Tex.
89th Semiannual Convention of the SMPTE, May 7–12, 1961, King Edward Sheraton, Toronto.
SPSE, Annual Conference, May 8–12, 1961, Arlington Hotel, Binghamton, N.Y.
ASME, Semiannual Meeting, June 11, 1961, Los Angeles.
AIEE, Summer General Meeting, June 18–23, 1961, Ithaca, N.Y.
NAVA, Annual Convention, July 22–25, 1961, Hotel Morrison, Chicago.
SPIE, National Convention, Aug. 7–10, 1961, Ambassador Hotel, Los Angeles.
Western Electronic Show and Convention, Aug. 22–25, 1961, San Francisco.
UFPA, Annual Meeting, August 1961, Berkeley Campus, U. of California.
90th Semiannual Convention of the SMPTE, Oct. 2–6, 1961, Lake Placid, N.Y.
Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, 1961, Hotel Biltmore, Los Angeles.
91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.
92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.
93rd Semiannual Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N.J.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
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